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FINAL

ENVIRONMENTAL ASSESSMENT

VALENTINE MILITARY OPERATIONS AREA

TEXAS

Prepared For:

TACTICAL AIR COMMAND

December 1989

Air Force
Environmental Planning Division
(HQ USAF/CEVP)

Room 5B269
1260 Air Force Pentagon
Washington, DC 20330-1260

16 Jul 93

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FINAL

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FINDING OF NO SIGNIFICANT IMPACT

The U.S. Air Force proposes to continue using the Valentine Military Operations Area (MOA) in southwest Texas for supersonic operations. The 49th Tactical Fighter Wing (TFW) at Holloman Air Force Base (AFB), New Mexico, has been flying supersonic operations above 15,000 feet (ft) mean sea level (MSL) in the MOA since January 1985. The majority of the operations will continue to be conducted in the F-15 aircraft. Occasionally, other fighter aircraft may use the airspace but their usage is negligible in comparison to the F-15s, and consequently, would result in no appreciable change from the evaluation and analysis for the F-15 aircraft.

The Air Force also proposes to grant permanent authority for supersonic operations in the Valentine MOA and to commit to periodic reviews of three years or less if any significant changes in operations and environmental conditions occur in the MOA.

The Record of Decision (ROD) allowing supersonic operations in the Valentine MOA stipulated: (1) Supersonic flight be limited to weekday, daylight operations of the 49th TFW and selected adversaries above 15,000 feet MSL, not to exceed 300 sorties per month in each MOA, (2) WSMR be first priority for supersonic training with the overflow equally divided between the Valentine and Reserve MOAs, (3) supersonic operations be confined to 22 X 28 mile elliptical areas, (4) supersonic flight not be conducted within five miles of the specific population centers, and (5) complaints and damage claims be resolved promptly. These operational restrictions resulted from a lack of definitive data to describe impacts of sonic booms. To this extent the research was conducted and the supersonic model used for predicting overpressures was validated as part of this environmental document.

The WSMR data shows the Oceana analysis, of data collected in the Warning Area 72 (Oceana MOA) off the coast of North Carolina, had over predicted noise impacts by ten decibels or more.

The mission of the 49th TFW is to maintain a state of readiness of personnel and equipment in order to conduct worldwide air superiority operations against enemy aircraft. The majority of the operations will be conducted in the F-15 aircraft although small numbers of other aircraft may participate in the exercises as well. An essential element in the effective accomplishment of this mission is realistic air combat training. Recent military experience indicates that combat crew effectiveness and the ability to survive hostile environments are directly related to the quality and quantity of previous training received.

Airspace requirements for the F-15 aircraft dictate the use of large supersonic operating areas to realistically employ the aircraft in the role for which it was designed and procured. To accomplish Tactical Air Command directed mission requirements and maintain a high level of unit combat capability, approximately 85 percent of the F-15 sorties need airspace set aside for supersonic flight. The F-15 supersonic flight is required so that the aircraft can utilize the supersonic flight capabilities during training. Supersonic flight regime is characterized by decreased maneuverability and high closure rates. By

eliminating speed restrictions, pilots are able to concentrate on the tactical situation of actual encounters and mission effectiveness is greatly enhanced. It is the policy of the U.S. Air Force, as specified in Air Force Regulation 55-34, Reducing Flight Disturbances, that supersonic operations be conducted over open water areas above 10,000 ft. MSL, to the maximum extent practicable. Overland supersonic flight is normally conducted above flight level 300 (30,000 ft. MSL). Deviations from the above supersonic flight policy, as in the case of the Valentine MOA, requires exception to this policy.

There are numerous alternatives to the proposed action, most of which either (1) utilize existing MOAs within 150 NM of Holloman AFB, (2) utilize existing supersonic airspace outside 150 NM of Holloman AFB by the refueling or temporarily deploying aircraft to another base, (3) create a new MOA capable of handling supersonic operations within 150 NM of Holloman AFB, and (4) invoke the no action alternative. Population concentration, conflicts with other operations (including commercial traffic), size and availability negate using existing MOAs within 150 NM of Holloman AFB. Time, cost, personnel relocation, availability, and quick reaction deployment posture are all factors which diminish the viability of utilizing existing airspace outside 150 NM of Holloman AFB. The feasibility for establishing a new MOA for T-38 and/or F-15 operations is very unlikely due to the number of existing MOAs, restricted areas, and high/low altitude airways. The no action alternative would result in a jeopardized mission for the 49th TFW with reduced and degraded training accommodations.

The total requirements of the 49th TFW is 1200 supersonic sorties per month. Only 300 such sorties are proposed at the Valentine MOA. The shortfall of 900 sorties per month are proposed for WSMR and Reserve MOA. Each of these operations is addressed in individual environmental documents.

The preferred alternative is the proposed action of conducting 300 supersonic sorties per month at the Valentine MOA. Implementing the proposed action contributes to fulfillment of the 49th TFW mission without serious adverse impact to the public, federal or state environmentally sensitive areas; natural resources; or any threatened or endangered species. In addition, the proposed action will not have a significant effect upon the natural or manmade environment, nor will it constitute a major federal action of significant magnitude to warrant preparation of an Environmental Impact Statement.

SUMMARY

1. Description of Proposed Action:

The 49th Tactical Fighter Wing (TFW) at Holloman AFB, New Mexico, proposes to continue to conduct approximately 300 supersonic sorties per month in the Valentine Military Operating Area/Air Traffic Control Assigned Airspace Area (MOA/ATCAA). The Valentine MOA is located in southwest Texas.

The Air Force also proposes to grant permanent authority for supersonic operations in the Valentine MOA but with periodic reviews of three years or less as operations and environmental conditions change.

The Record of Decision (ROD) allowing supersonic operations stipulated: (1) Supersonic flight be limited to weekday, daylight operations of the 49th TFW and selected adversaries above 15,000 feet MSL, not to exceed 300 sorties per month in each MOA, (2) WSMR be first priority for supersonic training with the overflow equally divided between the Valentine and Reserve MOAs, (3) supersonic operations be confined to 22 X 28 mile elliptical areas, (4) supersonic flight not be conducted within five miles of the certain population centers, and (5) complaints and damage claims be resolved promptly. These operational restrictions were imposed because of a lack of definitive data to describe impacts of sonic booms. To this extent research was conducted and the supersonic model used for predicting overpressures was validated.

2. Purpose and Need:

The mission of the 49th TFW is to maintain a state of readiness of personnel and equipment in order to conduct worldwide air superiority operations against enemy aircraft. The majority of the operations will be conducted in the F-15 aircraft although small numbers of other aircraft may participate in the exercises as well. An essential element in the effective accomplishment of this mission is realistic air combat training. Recent military experience indicates that combat crew effectiveness and the ability to survive hostile environments are directly related to the quality and quantity of previous training received.

Airspace requirements for the F-15 aircraft dictate the use of large supersonic operating areas to realistically employ the aircraft in the role for which it was designed and procured. To accomplish Tactical Air Command directed mission requirements and maintain a high level of unit combat capability, approximately 85 percent of the F-15 sorties need airspace set aside for supersonic flight. The F-15 missions require supersonic airspace so that the aircraft can utilize the supersonic flight regime capabilities during training. Supersonic flight regime is characterized by decreased maneuverability and high closure rates. By eliminating speed restrictions, pilots are able to concentrate on the tactical situation of actual encounters and mission effectiveness is greatly enhanced.

It is the policy of the U.S. Air Force, as specified in Air Force Regulation 55-34, Reducing Flight Disturbances, that supersonic operations be conducted over open water areas above 10,000 ft. MSL, to the maximum extent practicable. Overland supersonic flight is normally conducted above flight level 300 (30,000

ft. MSL). Deviations from the above supersonic flight policy, as in the case of the Valentine MOA, require exception from this policy.

3. Environmental Impacts:

The environmental impacts associated with the proposed action are a result of the aircraft flying greater than the speed of sound. The amount of time the aircraft would be supersonic is about one-half minute per sortie and is about two percent of the time currently spent in the MOA. The pollutants produced from aircraft operation would be emitted at a relatively high altitude and spread over a large area; consequently, the impact on local ambient air quality would be minor.

The primary impact and concern of local residents are the effects of sonic booms on people, domestic animals and wildlife, archeological sites, structures, and local economics. The Air Force had previously performed an intensive literature review on these various sonic boom effects. As stipulated, a sonic boom study was conducted and model developed in conjunction with this document to assess the magnitude of the impacts to the various environmental attributes.

The sonic boom study and analytical model was developed at White Sands Missile Range and applied to the Valentine MOA. Sorties during the study averaged 550 per month. At WSMR the average peak overpressure was less than 1.0 pounds per square foot (psf). The number of sonic booms experienced per day ranged from 0.6 near the center of the airspace to 0.2 at the fringes. C-weighted day-night noise levels (CDNL) ranged from 50 dB at the center of the airspace to 40 dB along the fringes. *For 300 sorties divided* as proposed at the Valentine MOA, the number of sonic booms heard at any location would decrease by about a factor of four while the CDNL levels would decrease by 0.6 dB. This resulting CDNL value (44.0 dB) is well within the EPA acceptability criteria for human annoyance. The average person outside the MOA would be expected to hear one sonic boom every ten days.

Sonic boom effects on domestic animals and wildlife has been evaluated. Species of special concern are the Peregrine falcon and bald eagle (both endangered), sheep, horses, and beef cattle. Review of available literature, information obtained on species response to sonic booms in other areas and special studies conducted for coordination under the Endangered Species Act indicate supersonic flight in the Valentine MOA will not significantly impact domestic animals or wildlife in the area. The Fish and Wildlife Service has concluded the proposed action will not jeopardize the continued existence of the Peregrine falcon. While the bald eagle is known to winter in the Centerfire Bog area, the area is remote from the supersonic maneuvering ellipse and consequently should not be affected.

Bighorn sheep on the Luke and Nellis AF Ranges have been exposed to sonic booms for a number of years. No noticeable effects in the population age structure, longevity, or reproduction success has been found for the sheep on the Nellis AF Range.

Domestic animals such as cattle, horses, sheep, and poultry show very little behavioral effect from exposure to sonic booms. Available literature and special

studies reviewed support the fact that animals and wildlife can and do flourish in the presence of military aircraft operations, both subsonic and supersonic. Fletcher concludes if subsonic aircraft noise (excluding sonic booms) were an adverse impact areas around large airports would be devoid of wildlife. This is also true for military operating areas and it should be noted that noise levels in MOAs are normally less than that at busy commercial airports and military airfield with jet activity.

Previously collected data related to the impact of sound induced vibrations on both modern and historical structures indicate that overpressures of 1 to 3 psf are significantly lower than the levels generally accepted as capable of damaging modern structures. Recent studies both in Europe and the American southwest have recommended 2.0 mm/sec. particle velocity to be the upper limit for induced motions in historic structures. Other studies indicate that sonic boom overpressures of less than 5 psf will result in particle velocities within this safe range. Consequently, if the overpressures resulting from Air Tactical Maneuvering are within the 1-3 psf range as indicated by the recent White Sands Boom Monitoring Project (average peak overpressure = 0.673 psf; maximum peak overpressure = 3.523 psf), there will be no impact to any of the classes of historic and archeological resources within the Reserve MOA.

The potential for sonic boom impact on the local economy has been evaluated and determined not to be significant. The evaluation included a review of population, employment, personal income retail trade, assessed valuation, real estate development, tourism, ranching, farming, mining, and forestry. In no case did any of the areas economic attributes indicate sonic booms would result in significant impact.

4. <u>Alternatives</u>:

There are numerous alternatives to the proposed action, most of which either (1) utilize existing MOAs within 150 NM of Holloman AFB, (2) utilize existing supersonic airspace outside 150 NM of Holloman AFB by the refueling or temporarily deploying aircraft to another base, (3) create a new MOA capable of handling supersonic operations within 150 NM of Holloman AFB, or (4) invoke the no action alternative. Population concentration, conflicts with other operations (including commercial traffic), size and availability negate using existing MOAs within 150 NM of Holloman AFB. Time, cost, personnel relocation, availability, and quick reaction deployment posture are all factors which diminish the viability of utilizing existing airspace outside 150 NM of Holloman AFB. The feasibility for establishing a new MOA for T-38 and/or F-15 operations is very unlikely due to the number of existing MOAs, restricted areas, and high/low altitude airways. The no action alternative would result in a jeopardized mission for the 49th TFW with reduced and degraded training accommodations and readiness.

The preferred alternative is the proposed action of conducting 300 supersonic sorties per month at the Valentine MOA. Implementing the proposed action contributes to fulfillment of the 49th TFW mission without serious adverse impact to the public, federal or state environmentally sensitive areas; natural resources; or any threatened or endangered species. In addition, the proposed

action will not have a significant effect upon the natural or manmade environment.

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I. PROJECT DESCRIPTION

A. Purpose

The U S Air Force proposes to continue using the Valentine Military Operations Area (MOA) in southwest Texas for supersonic operations. Figure I-1 shows the general location of the Valentine MOA. The 49th Tactical Fighter Wing (TFW) at Holloman Air Force Base (AFB), New Mexico, has been flying supersonic operations above 15,000 feet (ft) mean sea level (MSL) in the MOA since January 1985. The majority of the operations will continue to be conducted in the F-15 aircraft. Occasionally, other fighter aircraft may use the airspace but their usage is negligible in comparison to the F-15s, and consequently, would result in no appreciable change from the evaluation and analysis for the F-15 aircraft.

The Air Force also proposes to grant permanent authority for supersonic operations in the Valentine MOA. In granting the permanent authority, the Air Force commits to periodic reviews (minimum of three years or sooner if required) of operations and changing environmental conditions in the MOA. When there are proposed operational changes that could result in increased noise levels of one decibel C-weighted day-night noise level (types of aircraft, number of sorties, and etc.) and reconfiguration of the airspace (vertically or horizontally), or changes to the environmental resources of the MOA, the Air Force will initiate an environmental analysis to evaluate the potential environmental consequences of the proposals or continued operations.

The Record of Decision (ROD) allowing supersonic operations in the Valentine MOA, was signed by the Deputy Assistant Secretary for Installations on September 12, 1984. The ROD stipulated: (1) Supersonic flight be limited to weekday, daylight operations of the 49th TFW and selected adversaries above 15,000 feet MSL, not to exceed 300 sorties per month in each MOA, (2) WSMR be first priority for supersonic training with the overflow equally divided between the Valentine and Reserve MOAs, (3) supersonic operations be confined to 22 X 28 mile elliptical areas, (4) supersonic flight not be conducted within five miles of the towns Valentine, Ruidosa and Candelaria in the Valentine MOA and the towns

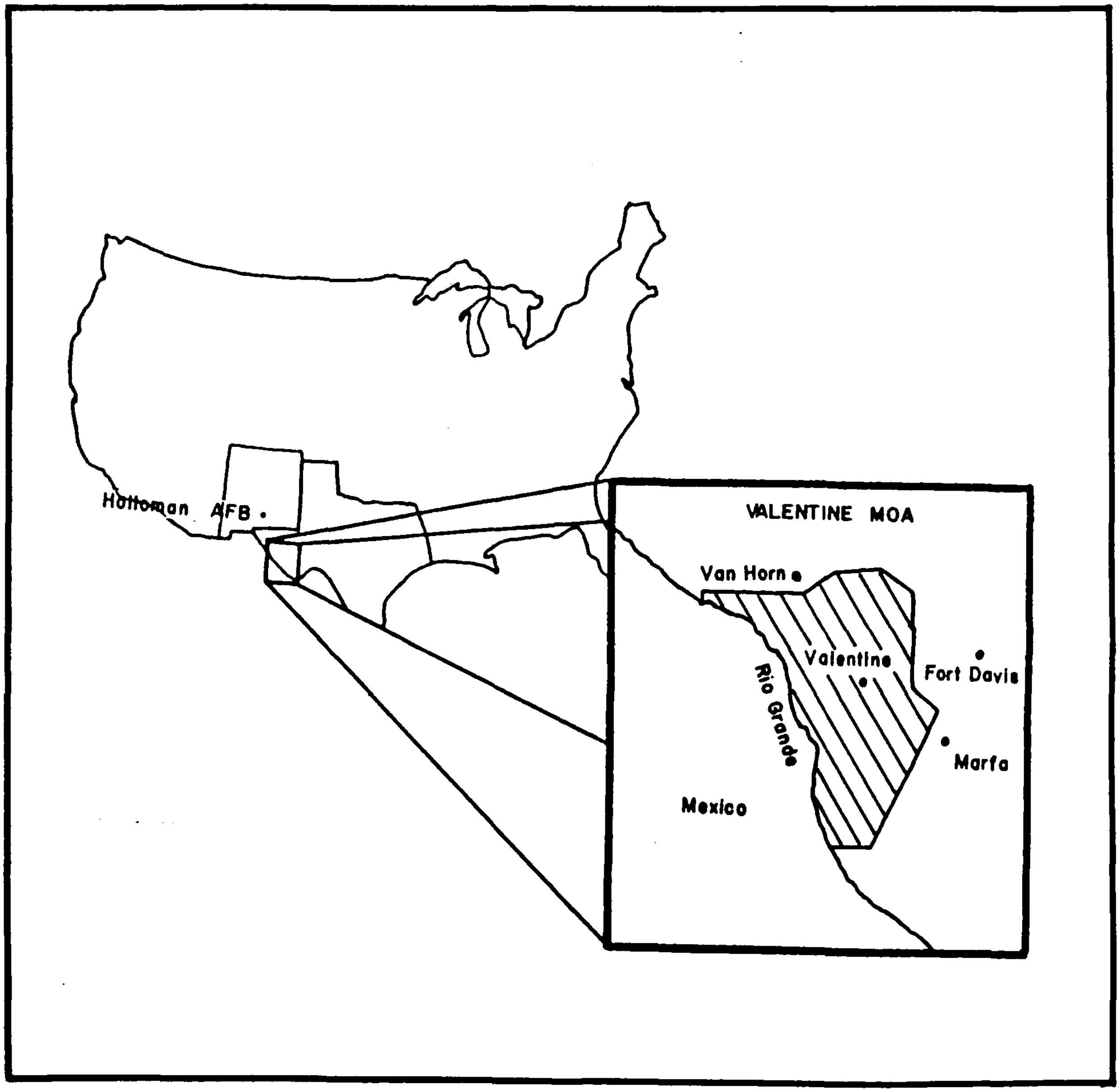

FIGURE I-1 Valentine MOA Perspective Map

of Reserve, Apache Creek, Horse Springs, and Aragon in the Reserve MOA, and (5) complaints and damage claims be resolved promptly. These operational restrictions were imposed by the Secretariat because of a lack of definitive data to describe impacts of sonic booms. To this extent the secretariat directed research be conducted and the supersonic model used for predecting overpressures be validated. This study was conducted within the WSMR from July 1988 to January 1989.

In addition to facilitating continued approval for supersonic operations in the MOA, this environmental assessment provides an updated noise analysis based on the results of the sonic boom model validation. The previous analysis of sonic boom impacts was based on the sonic boom model developed from operational data collected in the Warning Area 72 (Oceana MOA) off the coast of North Carolina. The WSMR data shows the Oceana analysis over predicted noise impacts by ten decibels or more.

The Air Force proposes to allow supersonic operations throughout the Valentine MOA except within five miles of the towns of Valentine, Ruidosa and Candelaria. Supersonic flight would continue to be limited to weekday, daylight operations of the 49th TFW and selected adversaries at an altitude not below 15,000 feet MSL. Sorties would not exceed 300 per month, and priority consideration for scheduling would be given to WSMR; however, the Valentine and Reserve MOAs could be scheduled directly when WSMR is known not to be immediately available (operations would continue to be equally divided between the Valentine and Reserve MOAs). The objective of this document is to evaluate the potential impact of supersonic flight operations in the existing Valentine Military Operations Area (MOA)/Air Traffic Control Assigned Airspace Area (ATCAAA) located in the Trans Pecos region of Southwestern Texas. Figure I-1 shows the general location of the Valentine MOA. The purpose of this evaluation is to renew permission to continue supersonic training operations at this location.

B. Missions

The mission of the 49th TFW is to maintain a state of readiness of personnel and equipment in order to conduct worldwide air superiority operations against enemy aircraft, if the need arises.

Essential to this mission is realistic air combat training to insure that in time of conflict, tactical forces are prepared and capable of defeating the adversary. Recent military experience indicates that combat crew effectiveness and their ability to survive hostile environments are directly related to the quality and quantity of previous training received.

Airspace requirements for the F-15 aircraft dictate the use of large operating areas which allow periodic, short-term supersonic flight. By eliminating speed restrictions, pilots are able to concentrate on realistic tactical situations and mission effectiveness is thus greatly enhanced.

The USAF Tactical Air Command's (TAC) flying hour program directives dictate that the 49th TFW at Holloman AFB needs to accomplish 1200 sorties using airspace approved for supersonic flights (training flights) per month in order to meet proficiency objectives of its mission.

The 49th TFW would prefer to conduct all sorties (i.e., sorties requiring approved for supersonic flight) over the adjacent U.S. Army White Sands Missile Range (WSMR) since its proximity would facilitate coordination and oversight activities as well as reducing the costs associated with flying the F-15 aircraft. However, the Army's ongoing missions at WSMR preclude the conduct of all the sorties required by the 49th TFW.

Over the course of time, the Commanders at the 49th TFW and WSMR have given close attention to operational requirements and have adjusted airspace/range management policies to better utilize the WSMR assets. In an attempt to meet sortie requirements, the 49th TFW has divided the available WSMR airspace into smaller parcels (limiting full capability of radar use and intercept operations),

reduced individual sortie time (limiting actual number of battle engagements) and provided closer scheduling of sorties. These arrangements allow the 49th TFW to fly from 600 to 900 sorties per month at WSMR. Although these steps have been necessary in order to increase the wing's overall mission capabilities, the necessary compromises have resulted in a degradation of the individual aircrew's rate of achieving combat proficiency.

The Army's research and development operations at WSMR have priority over the 49th TFW's mission and consequently, WSMR cannot commit to support any set number of sorties. Although the 49th TFW has been able at times to conduct up to 900 sorties per month at WSMR, many of these have been degraded sorties (reduced time, altitude or geographic constraints). Over the long-term, using historical range availability, the USAF believes 600 supersonic sorties per month can be accommodated at WSMR. The higher rate (900 sorties per month) at WSMR is not a realistic expectation on a long-term basis, thus, WSMR alone could never provide for needed combat aircrew readiness.

An additional limitation is the WSMR airspace requirements of the 479th Tactical Training Wing (TTW), which is also stationed at Holloman AFB. The 479th TTW is charged with indoctrinating all new fighter aircrews to the basic concepts of fighter operations in the T-38 Talon aircraft. Due to the short operating range of the T-38 aircraft, the suitable airspace is required in proximity (90 nautical miles) to Holloman AFB. Approximately 150 to 160 T-38 sorties are scheduled daily to operating airspaces located within 80 nautical miles of Holloman AFB.

The 49th TFW proposes to continue supersonic air combat operations in two additional sparsely populated areas: the Valentine MOA in southwest Texas and that part of the Reserve MOA located in west central New Mexico (Figure I-2). At WSMR a minimum of 600 air combat operations per month could be achieved. To fulfill the 1200 sorties per month, the Valentine MOA must contribute a maximum of 300 sorties per month. It should be noted that the 49th TFW will attempt to fly all sorties that have a reasonable probability of supersonic flight occurrence at WSMR, and that the Valentine MOA will be used only as an overflow area for conducting those sorties which cannot be flown at WSMR. However, for

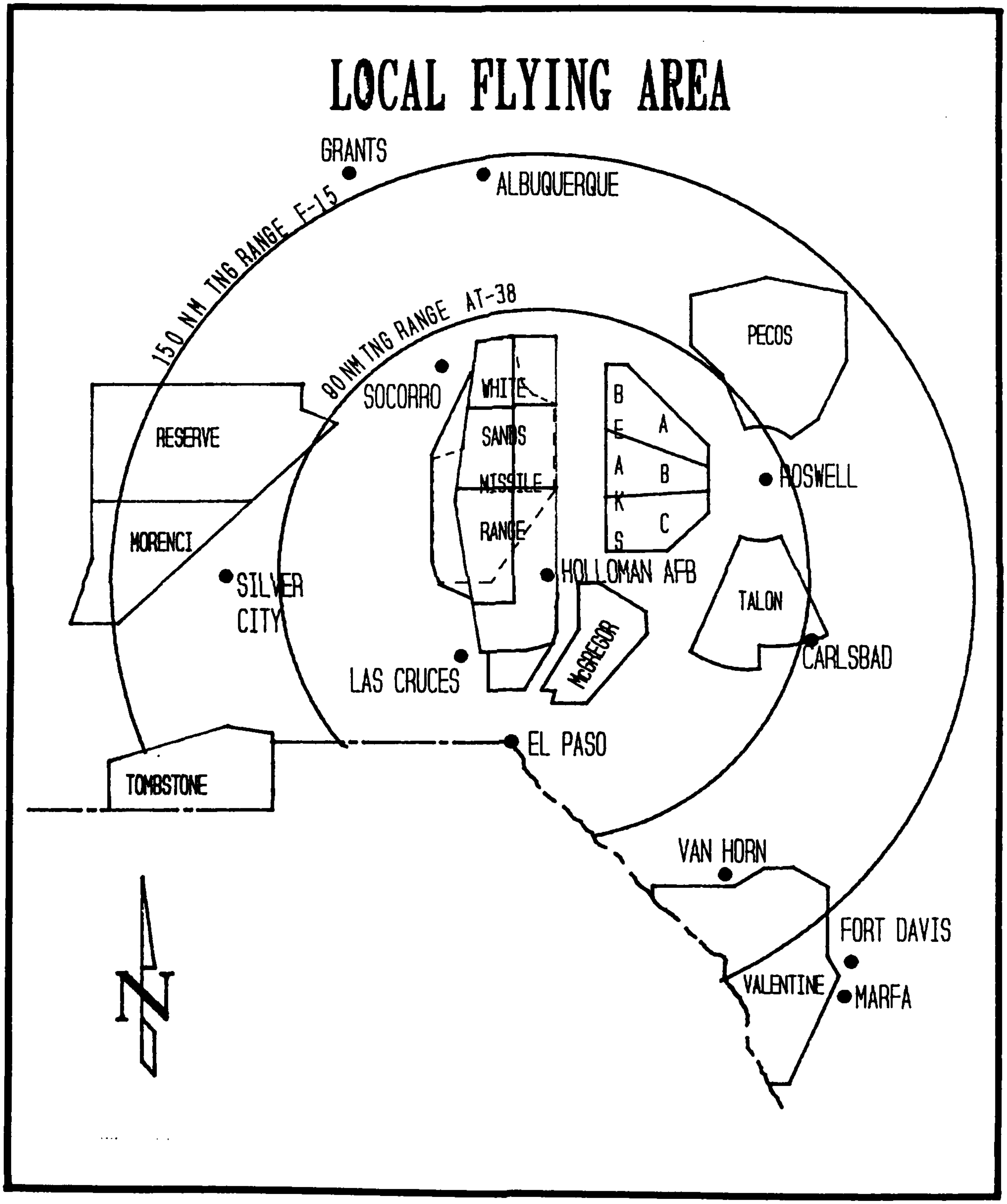

FIGURE I-2 Flying Areas Near Holloman AFB

the purpose of evaluating environmental impacts, this document assumes the maximum of 300 sorties per month will be flown at Valentine MOA. In addition, it is anticipated that a maximum of 300 sorties per month will be flown at the Reserve MOA.

In an effort to mitigate the potential impacts of sonic booms on the public, the 49th TFW proposes to utilize three areas (Valentine, WSMR, and Reserve) which would obviate heavy concentrations of sonic boom activity on any one area. Because of the lack of permanent population underneath a large portion of the WSMR area currently approved for supersonic operations, the 49th TFW proposes to continue using WSMR as its primary airspace for conducting training that requires airspace approved for supersonic flight. The Reserve and Valentine MOAs will be used as backups in the event WSMR cannot accommodate all 49th TFW sorties. Environmental Assessments (EA) similar to this document are being accomplished for WSMR and the Reserve areas.

II. AIR FORCE FLYING ACTIVITIES

A. General

All the military flying areas in the vicinity of Holloman AFB are depicted previously in Figure I-2. These areas must accommodate approximately 160 T-38 and 50 to 70 F-15 training sorties per day. WSMR, Valentine, and Reserve areas are currently the only supersonic areas (i.e., areas approved for supersonic flight) within 400 miles of Holloman AFB. The F-15 and T-38 aircraft share available WSMR training time when the airspace is not being used for WSMR research and development projects. Because of the short operating range of the T-38 aircraft and the shared use of WSMR, all other areas within 90 nautical miles of Holloman AFB (Beak MOAs, Talon MOA, and the McGregor Range) must be used for T-38 operations. The majority of the F-15 sorties are flown within WSMR and the outlying MOAs of Pecos, Reserve, and Valentine. The subsonic Pecos and Reese 3 MOAs are used by other USAF bases and cannot provide the training time involving supersonic flight required for Holloman AFB aircraft.

B. Valentine MOA Operations

The Valentine area is presently utilized for up to 300 subsonic sorties per month. The F-15 flying programs are designed to provide participating pilots with the most demanding and realistic combat training possible.

Pilots in the 49th TFW are not students as in the Air Training Command. Most F-15 pilots are qualified in the aircraft before arriving at Holloman AFB. The few pilots who complete their transition flying at Holloman AFB are already highly experienced in fighters. Operations in the Valentine MOA will be oriented toward simulating combat maneuvers, not student training. The program consists of four phases, as described in the following paragraphs.

1. Transition Phase

This phase is the initial aircraft familiarization phase for those pilots transitioning from other aircraft such as the F-4 to the F-15. It is the first phase of tactical operations and provides the pilot with basic skills, proficiency and knowledge in the operation and handling characteristics of the new aircraft.

If restricted to subsonic flight regime only, pilots are denied valuable experience in the vastly different performance and handling characteristics of the aircraft in the flight envelope at speeds above Mach 1.0 (i.e., the speed of sound). Thus concentration on the 49th TFW's specific mission objective is impeded.

2. Basic Fighter Maneuvers

After the transition phase, pilots enter the basic fighter maneuver phase with air-to-air combat. Flights consisting of two aircraft practice standardized offensive and defensive maneuvers both singularly and in combination. Pilots develop the aerial skills, judgement, and weapon systems knowledge to effectively fly their aircraft in the three dimensions relative to an airborne adversary--the objective being to maneuver the aircraft efficiently to negate a potential threat while achieving a position of advantage for simulated weapons launch. This phase of operation is the pilot's first exposure to the three dimensional aerial arena.

3. Air Combat Tactics

In this advanced phase of flying, pilots sharpen their tactical skills while developing new and innovative combat tactics. Air combat tactics require a comprehensive flight profile designed to insure the best possible tactical employment of flights consisting of more than one aircraft.

Basic Fighter Maneuver training pits the individual pilot against a designated adversary. Air combat tactics, however, concentrate effective employment of up to four aircraft as tactical partners or as a team to maintain offensive and defensive mutual support. Sophisticated radar and visual identification systems are employed at long-range to arrive at a visual close-in, three dimensional air-to-air engagement (dogfight).

4. Dissimilar Air Combat Tactics

Pilots at this level of proficiency employ air combat tactics against simulated adversaries in different types of aircraft, such as the F-5, F-4, or F-16. The objective of the mission is to provide each pilot with experience against Navy and other Air Force fighter aircraft to simulate foreign aircraft in size, performance, and tactical capabilities. Flight size varies from four to eight aircraft with airspeed and altitude parameters the same as Air Combat Tactics phase.

III. AFFECTED ENVIRONMENT

A. Climate

1. General

Unless otherwise noted, the climatic conditions (long-term averages) described herein are a composite of data compiled by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) at stations in Presidio and Van Horn Texas (1941-1970) and Alpine Texas (1951-1980). These cities essentially ring the Valentine MOA (Figure III-1). The climate in the area is arid sub-tropical with average total precipitation ranging from 8.61 to 14.83 inches per year. Snowfall is rare and is considered of little importance. Irrigation is required to support plant life other than desert vegetation. Winters are characterized by fair, dry weather with mild days and cool nights. Freezes occur about half the time during December and January. The lowest recorded temperatures were -7°, -2° and 4°F at Van Horn, Alpine, and Presidio, respectively. Upper summer daytime temperatures range from warm (under 95°F) at Van Horn to over 100°F at Presidio.

2. Wind

Recorded weather data at Presidio, Van Horn, and Alpine did not contain historical wind speed and direction information. However historical wind data at El Paso, Texas (150 miles to the northwest) between 1951 and 1960 provide an indication of regional wind trends. The average wind speed is nine miles per hour (MPH) from the north. The strongest winds have been in the spring averaging 11.3 MPH from the west southwest.

3. Precipitation

Annual precipitation across the Valentine MOA has ranged from, 1.64 inches at Presidio, Texas in 1956 to 27.27 inches at Van Horn, Texas in 1941. The average annual precipitation for this area is between nine and 10 inches of which about

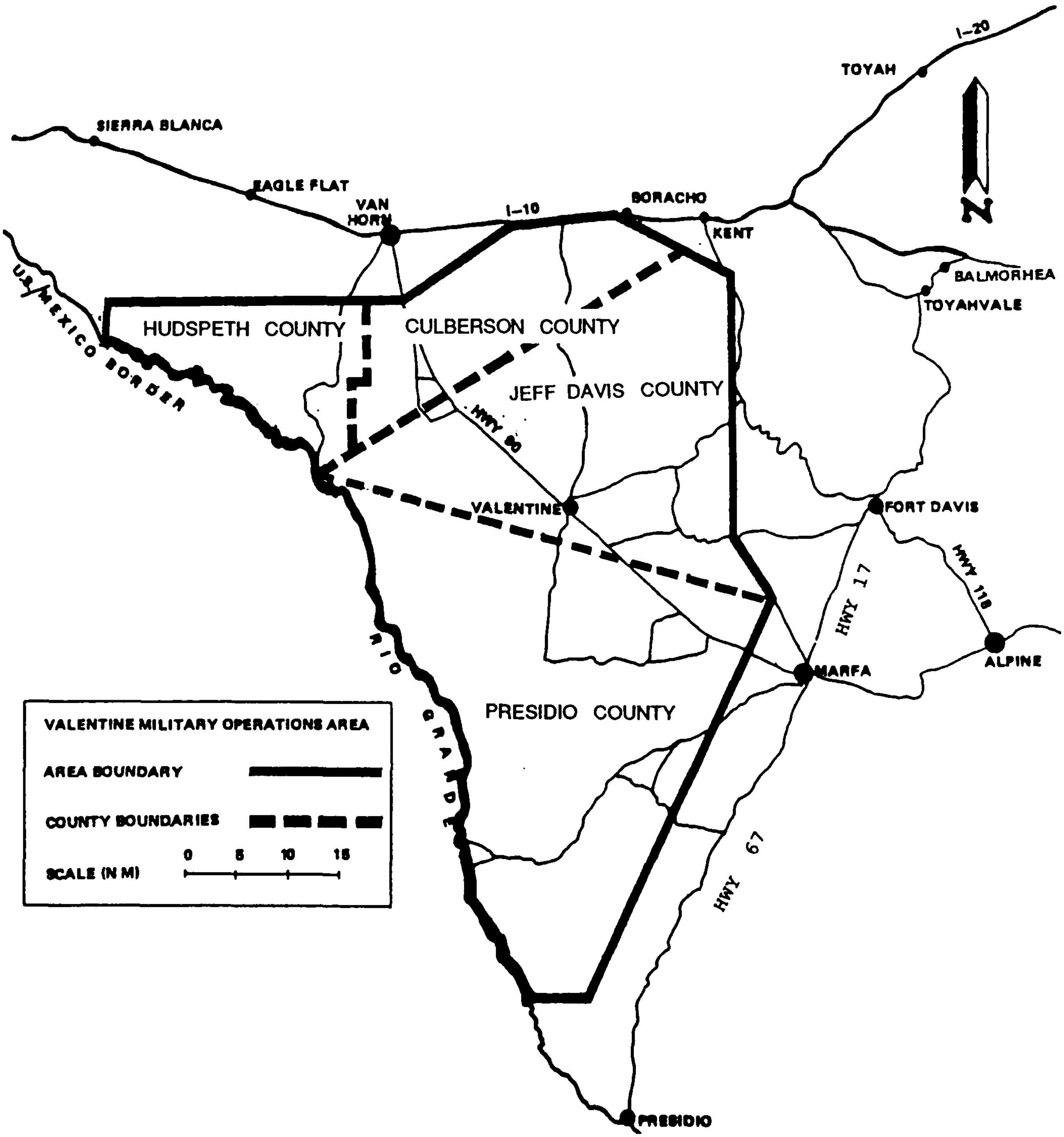

FIGURE III-1 County Boundaries and Towns in the Vicinity of the Valentine Military Operations Area

75 percent to 80 percent occurs from May through October. Showers greater than 0.10 inches occur about once every 10 days during the summer. Very little precipitation occurs from February through April. Heavy snows (7-13 inches) have occurred at Van Horn, but are so infrequent as to be considered unimportant.

4. Cloud Cover/Sunshine

The area receives abundant sunshine all year long. Sunshine averages from 70 to 80 percent throughout the year. Sunshine is slightly reduced during the fall months to about 76 percent. Sky cover between sunrise and sunset at El Paso, TX, 150 miles northwest of the MOA, averaged 38 percent between 1951 and 1980. During an average year, 193 days would be clear; 99, partly cloudy; and 73, cloudy.

5. Visibility

Although historic records indicate that about 2.2 days per year will exhibit heavy fog with visibility of 0.25 miles or less, no such fog was observed June through August of the recording period 1951 to 1980. The highest probability of heavy fog occurs in December and January with 0.6 and 0.7 days, respectively.

6. Relative Humidity

The area is arid subtropical with a mean monthly relative humidity of about 45 percent in January, from 30 percent to 38 percent in April, about 40 percent in July, and from 38 percent to 45 percent in October. Due to night time cooling, relative humidity increases at night with maximum value occurring in early morning near sunrise and minimum values occurring at early evening near sunset. The noon values of relative humidity are normally less than 20 percent of the morning levels and 10 percent more than the evening levels.

B. Geology

1. Physiography

The upper Rio Grande Basin is situated within what is generally termed the Trans-Pecos region. Figure III-2 depicts the physiography of the Trans-Pecos region. The Trans-Pecos consists of mountains and canyons and stretches of plateaus and plains between two relatively broad valleys, the Rio Grande on the west and the Pecos River on the east. Generally, the mountains are irregular in shape, trend south and southeast and are separated by parallel belts of lowlands or bolsons. The Rio Grande is the only permanently flowing stream in the area of the Valentine MOA, and forms a border on the west and south of the MOA. All other streams are ephemeral.

2. Regional Geology

The geology of the Rio Grande basin is complex and features evidence of many geologic processes including faulting, folding, and igneous intrusions. Exposed rocks in the basin range in age from Precambrian to Recent, with nearly all geologic systems being represented. The majority of rocks are of sedimentary origin; however, igneous rocks occupy a large part of Jeff Davis and Presidio counties (Gates et al. 1980).

Unconsolidated Tertiary and Quaternary deposits fill the basins. Volcanic, volcanic-clastic, and intrusive rocks of Tertiary age out crop over much of the region including areas of the Quitman, Eagle, and Van Horn Mountains. They comprise most of the Sierra Vieja highlands south of the Wylie Mountains and the Davis, Chinati, and Bofecillos Mountains (Gates et al. 1980).

Limestone and sandstone rocks of Cretaceous age form outcrops on the southern Diablo Plateau, between the Davis and Apache Mountains and in the Van Horn Mountains. Rocks of Permian age, primarily limestone, crop out in the Wylie, Apache, Delaware, and Guadalupe Mountains and on the Diablo Plateau.

Source: Schmidly, D.J. 1977

FIGURE III-2 Major Physiographic Features of the Trans-Pecos

The Texas Lineament, a prominent structural feature crossing the area along the northern side of Eagle Flat, is considered by some geologists as part of a transcontinental fracture zone (Gates et al. 1980). At Eagle Flat, the Texas Lineament coincides with the boundary between the Diablo Plateau and the Chihuahua Trough. Structurally, this is a low area underlain by thick deposits of mostly Cretaceous age. A generalized geologic map of the Upper Rio Grande Basin is given in Figure III-3. Major geologic units and their water bearing characteristics are detailed in Table III-1.

C. Soils

The soils of the Valentine MOA (Figure III-4) consist primarily of three soil associations: 1) Redona-Verhalen-Reagan association, 2) the Musquiz-Santo Tomas-Boracho association, and 3) the Nickel-Canutio-Delnorte association. For the most part, these three associations, which comprise approximately 65 percent of the MOA, are deep soils and subsoils resting on beds of caliche and gravel. The texture of the soils range from fine sand to clay with clay loams as the predominate texture (Table III-2).

These soils support a variety of vegetation depending upon annual rainfall amounts. The Redona-Verhalen-Reagan and Nickel-Canutio-Delmonte associations in the area experience an annual rainfall of 6-14 inches. Both have sparse amounts of desert scrub vegetation. The Musquiz-Santo Tomas-Boracho association maintains a moderate cover of grass instead of desert scrub vegetation because of area's increased average rainfall, some over 15 inches of rainfall annually. These main soil associations within the MOA primarily support rangeland and wildlife habitat.

The remaining 35 percent of the MOA consists of soils ranging from deep sands to shallow gravelly loams. Also included in the remaining soil associations is exposed igneous rock. In most cases, these soils mainly support rangeland and habitat for wildlife. However, along the Rio Grande River, some areas allow irrigated cropland.

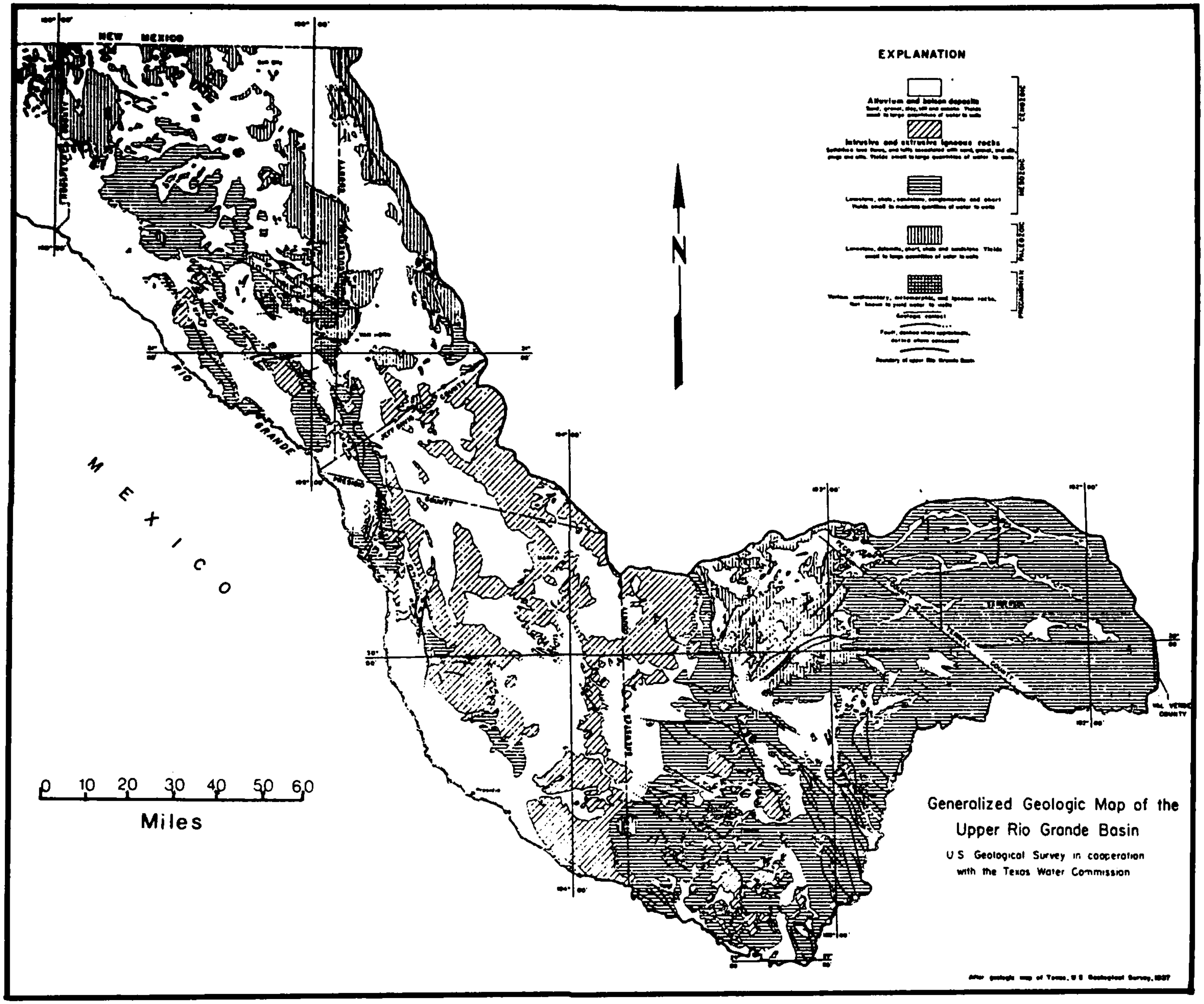

FIGURE III-3 Generalized Geologic Map of the Upper Rio Grande Basin

TABLE III-1. Water-bearing characteristics of geologic units that are significant sources of ground water

ERATHEM	SYSTEM	UNIT	PHYSICAL AND LITHOLOGIC CHARACTERISTICS	WATER-BEARING CHARACTERISTICS (YIELDS TO WELLS ARE DEFINED AS SMALL WHEN LESS THAN 50 GAL/MIN., MODERATE WHEN BETWEEN 50 AND 500 GAL/MIN., AND LARGE WHEN GREATER THAN 500 GAL/MIN.
CENOZOIC	Quaternary	Rio Grande alluvium and alluvium of tributary streams	Gravel, sand, silt, and clay deposited by the Rio Grande and its tributaries; may be as much as 200 feet thick at some locations.	Supplies moderate to large quantities of fresh to moderately saline wter in the Rio Grande Valley in the Mesilla, Hueco, and Presidio bolsons, at the lower ends of Red Light Draw and Green River Valley and the Presidio bolson; alluvium of tributary streams is commonly unsaturated in many basins but supplies small amounts of freshwater for domestic and stock use in the Presidio bolson and near the Rio Grande in other basins.
	Quaternary and Tertiary	Bolson deposits	Clay, silt, sand, and gravel deposited by the ancestral Rio Grande or streams local to individual basins; commonly 1,000 to as much as 9,000 feet thick (in the Hueco bolson).	Principal freshwater aquifer in western-most Texas; supplies moderate to large quantities of fresh to slightly saline water in basin areas; contains moderately saline or poorer quality water at depth in the Hueco bolson and in parts of the Hueco, Mesilla, and Presidio bolsons and the Salt Basin, mostly in fine grained lacustrine and alluvial deposits.
	Tertiary	Volcanic-clastic and volcanic deposits	Reworked tuffs and alluvial deposits consisting almost exclusively of volcanic debris (volcanic clastics) interbedded with ash-fall tuffs and volcanic flows or ash-flow tuffs; up to 6,000 feet thick at Ryan Flat.	Supplies small to large quantities of fresh-water in Ryan and Lobo Flats; probably occurs at depth in Red Light Draw, Green River Valley and southeastern Presidio bolson; premeable zones probably most common in the uppermost 1,000 feet and may include well-reworked tuff, well-sorted volcanic clastics, weathered zones above and below volcanic flows, and possibly fractured volcanic-flow rocks.
MESOZOIC	Cretaceous	Limestones, undifferentiated, but including the campagrande Formation, Bluff Mesa Limestone, and Yucca Formation; and the Cox Sandstone	Limestone units include beds of marl, sandstone, conglomerate, siltstone and shale, and locally aggregate more than 5,000 feet in thickness; Cox Sandstone is mostly quartz sandstone with some pebble conglomerate and siltstone, shale, and limestone; very fine- to medium-grained; commonly less than 200 feet thick, but can be as thick as 700 feet.	Limstones supply small to moderate quantities of fresh to moderately slaine water in the Sierra Blanca area; Cox Sandstone supplies small to moderate quantities of fresh to moderately saline water in the southeastern Hueco bolson, the Sierra Blanca area, and eastern Wildhorse Flat.
PALEOZOIC	Permian	Limestones, including the Capitan Limestone, the Goat Seep Limestone, and the Bone Spring and Victorio Peak Limestones, undifferentiated; and sandstones, including the Delaware Mountain Group	Capitan and Goat Seep Limestones are massive, thick-bedded reef limestone and dolomite; Capitan is 1,000-2,000 feet in the Guadalupe Mountains and Beacon Hill area and up to 900 feet thick in Apache Mountains area; the Goat Seep is up to 1,200 feet thick in the Guadalupe Mountains area; the Bone Spring and Victorio Peak Limestones are limestone and dolomite with sandstone and siltstone, aggregate thickness 1,800 to more than 3,000 feet; the Delaware Mountain Group is sandstone and limestone with some siltstone, aggregate thickness is on the order of 3,000 feet.	Capitan and Goat Seep Limestones supply moderate to large quantities of fresh to slightly saline water in the Beacon Hill area and the Capitan supplies moderate to large qauntities of fresh and slightly saline water in the Apache Mountains area; the Bone Spring and Victorio Peak Limestones supply small to large quantities of slighttly to moderately saline water in the Dell City area and the northeastern Diablo Plateau; the sandstones and limestones of the Delaware Mountain Group supply small quantities of slightly to moderately saline water along the eastern side of the northern Salt Basin and the foothills of the Delaware Mountains.
PRE-CAMBRIAN	......	Carrizo Mountain Formation and possibly Allamoore Formation	Carrizo Mountain Formation is metaigneous rocks; Allamoore is limestone, conglomerate and metamorphic, volcanic, and igneous rocks.	Supplies small quantities of freshwater in the Allamoore area, permeable zones probably are weathered or fractured rock.

Source: Gates, J.S. et al. 1980. Availability of Fresh and Slightly Saline Groundwater in the Basins of Westernmost Texas. Texas Department of Water Resources. Report 256.

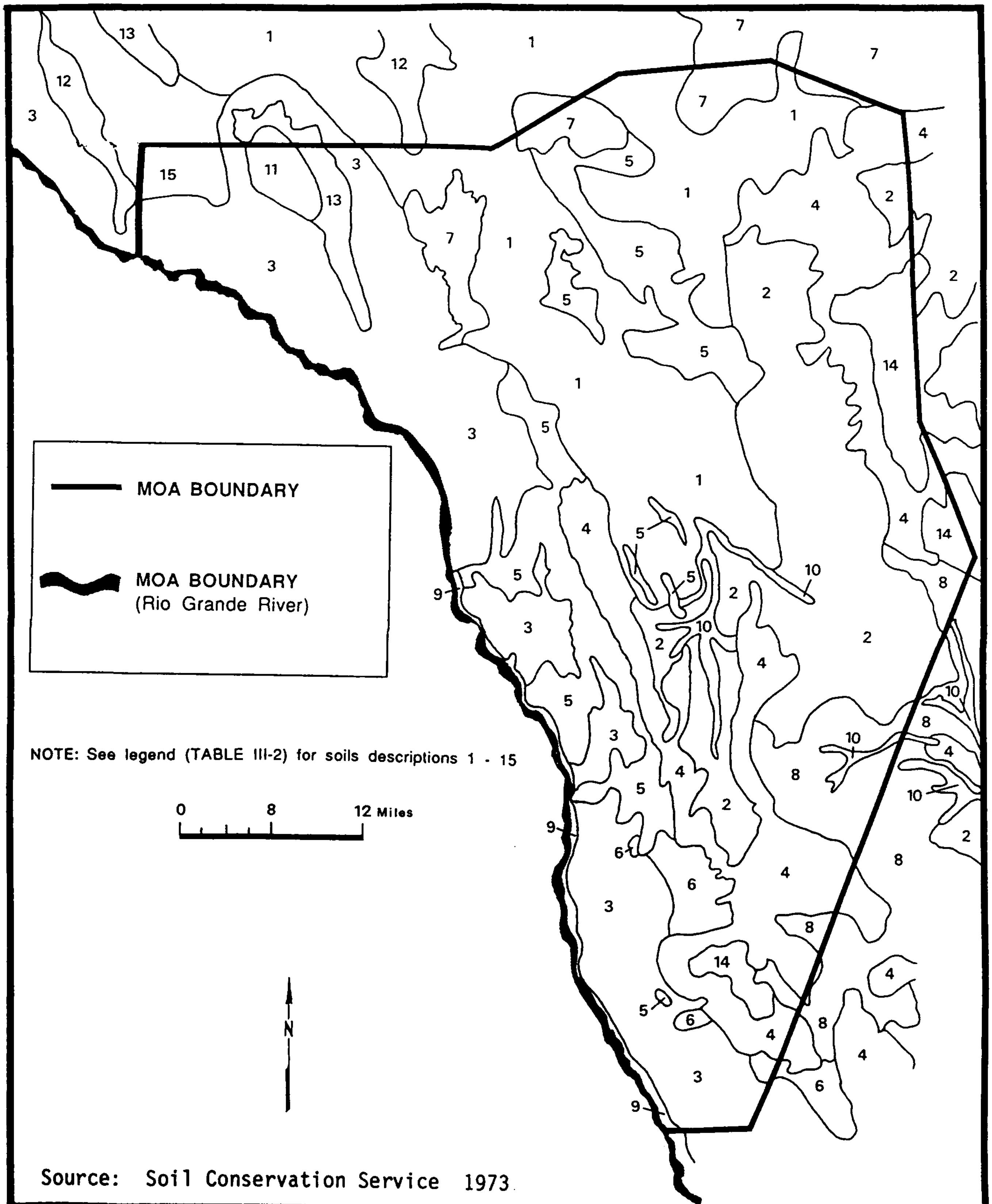

FIGURE III-4 Soil Types of the Valentine MOA

TABLE III-2

Valentine MOA Soil Descriptions

1	REDONA-VERHALEN-REAGAN Association: Deep, nearly level to gently sloping, noncalcareous to calcareous, light colored soils on valleys and plains between the mountains. About 40% of the soils are made up of sandy loams to clays with surface layers that range from 6 to 60 inches thick. Approximately 60% of the association is made up of soils that are more gravelly, more shallow or less clayey which occur in small drains or narrow ridges. Their main use is for rangeland and wildlife. Production potential is moderate for adapted species.
2	MUSQUIZ-SANTO TOMAS-BARACHO Association: Deep to shallow, nearly level, calcareous and noncalcareous dark colored soils on intermountain valleys. Approximately 55% of the soils in this association consist of loams and very gravelly loams to clay loams with surface layers that range in thickness from 7 to 24 inches. About 45% of the association is made up of soils that differ in being on flats or on old high terraces and fans next to mountains. Their main use is for rangeland and wildlife. Production potential is high for adapted species.
3	NICKEL-CANUTIO-DELNORTE Association: Deep to shallow, undulating to rolling, light colored, calcareous, gravelly soils on rolling hills. About 75% of the soils in this association consist of gravelly loams to fine sands with caliche covered pebbles through out. The surface layers range from 6 to 8 inches thick. About 25% of the association is made up of badlands and similar soils that are deeper and less gravelly. Their main use is for rangeland and wildlife. Production potential is low for adapted species.
4	BREWSTER Association: Shallow and very shallow, non calcareous, dark colored soils on steep hills and low mountains of igneous rock. The soils in this association are located in the lower part of the Davis Mountains where elevations are 4,500 to 5,000 feet. About 60% of the soils are made up of a neutral stoney loam with a surface layer approximately 7 inches thick. About 40% of the association is made up of similar soils that are generally more clayey except where igneous rock outcrops occur. Their main use is for rangeland and wildlife. Production potential is moderate to high for adapted species.
5	VOLCA-BREWSTER-ECTOR Association: Shallow and very shallow, hilly and steep, calcareous and noncalcareous, dark colored soils on igneous hills. About 90% of the association is made up of loams with a surface thickness of 7 to 9 inches over a layer of bedrock. About 10% of the association is made up of deeper soils in narrow drains.

Their main use is for rangeland and wildlife. Production potential is moderate for adapted species.

6 LOZIER Association: Very shallow, hilly and steep, light colored, calcareous soils on limestone hills. About 50% of this association is made up of gravelly loams over a limestone layer. The limestone bedrock occurs at a depth of about 12 inches. About 25% of the association contains similar but darker soils. The last 25% consists mainly of limestone rock outcrops and less gravelly lozier soils. Their main use is for rangeland and wildlife. Production potential is low to moderate for adapted species.

7 ECTOR-ROCK OUTCROP: Shallow, hilly to steep, calcareous, stoney, dark colored soils of limestone hills and mountains. Approximately 50% of the association is made up of a gravelly loam laying over fractured limestone. The surface layer is about 7 inches thick. About 40% of this association is made up of exposed limestone. Other soils in draingeways and footslopes make up about 10% of the association. They are used for rangeland and wildlife. Production potential is moderate for adapted species.

8 BARACHO-MITRE Association: Shallow and very shallow, rolling and undulating, dark colored, calcareous and noncalcareous soils on footslopes of igneous hills and mountains. About 80% of the association is made up of gravelly loams situated over caliche and igneous rock formations. The surface layers are generally about 12 inches thick. About 20% of the association consists of less gravelly minor soils. Their main use is for rangeland and wildlife. Production potential is moderate for adapted species.

9 GLENDALE-ANTHONY-TOYAH Association: Deep, nearly level, light to dark colored, calcareous soils on the flood plains of large rivers and arroyos. About 90% of the association consists of clay loams, sandy loams, and gravelly sands with a surface layer from 12 to 16 inches thick. Approximately 10% of the association consists of similar soils with different textures. Their primary use is for rangeland and wildlife however, some areas along the Rio Grande are used for irrigated cropland. Production potential is high for adapted species.

10 GAGEBY-ROCHOUSE Association: Deep, nearly level, dark colored, calcareous and noncalcareous soils in small flood plains. About 90% of this association is made up of silt loams grading to either clay loam or sand about 12 to 15 inches. Approximately 10% of the association is made up of soils on sloping terraces above the flood plains. Their main use if for rangeland and wildlife. Production potential is high for adapted species.

11	ROCK OUTCROP-BREWSTER Association: Shallow, hilly to very steep dark colored, noncalcareous soils and igneous rock outcrop of the hills and mountains. About 60% of the association is exposed igneous rock outcrop. About 40% consist of a 7 inch thick stony loam surface layer. Their main use is for rangeland and wildlife. Production potential is moderate to high adapted species.
12	ALLAMORE-BEACH-ROCK OUTCROP: Shallow to very shallow, hilly to very steep, dark colored calcareous soils and sandstone rock outcrop of hills and mountains. About 70% of the association consists of gravelly loam soils with surface layers from 6 to 11 inches thick. Approximately 30% of the association consists of exposed sandstone rock outcrop. Their main use is for rangeland and wildlife. Production potential is moderate for adapted species.
13	LOZIER-ROCK OUTCROP Association: Very shallow to shallow, strongly sloping to steep, light colored, calcareous soils and limestone rock on hills and mountains. Loamy soils to caliche with a surface layer of approximately 6 inches make up about 60% of the association. Approximately 30% of the area is comprised of limestone rock outcrop. Soils in drainageways make up the other 10% of the area. They are used mainly for rangeland and wildlife. Production potential is low for adapted species.
14	MAINSTAY-LIV-BREWSTER Association: Very shallow to moderately deep, hilly and steep, dark colored, noncalcareous soils on igneous mountains. Usually above 5,500 feet elevation. Approximately 70% of the association consists of silty loams to clays with a surface layer ranging in thickness from 7 to 38 inches. The remaining 30% consists of igneous rock outcrops and deep clayey soils. They are mainly used for rangeland and wildlife. Production potential is high for adapted species.
15	WINK-SIMONA Association: Moderately deep to shallow, nearly level to sloping, light colored, calcareous, loam and gravelly soils on uplands. About 90% of the area consists of fine sandy loams to gravelly loams with surface layers 3 to 6 inches thick. Other soils which are deeper and sandier comprise approximately 10% of the association. They are used for rangeland and wildlife. Production potential is low to moderate for adapted species.

D. Air Quality

No air quality monitoring has recently been conducted within Jeff Davis, Hudspeth, Culberson, or Presidio counties (Personal communication, Mr. Larry Butts, 1987). Historically, however, the air quality throughout the region has been good. Each county has been reported to be in attainment with National Ambient Air Quality Standards (NAAQS) for: sulphur dioxide (SO_x), carbon monoxide (CO), nitrogen dioxide (NO_x), and Total Suspended Particulates (TSP). There has been no air quality monitoring conducted within this region to determine compliance or non-compliance with national ozone standards. National ambient air quality standards are presented in Table III-3.

E. Noise

Normal activities in and around the Valentine MOA are ranching, outdoor recreation, and tourism. No significant industrial activities exist within the MOA boundary. Although no historical noise data were found, baseline noise levels are expected to be below "normal" rural area noise levels primarily due to the sparse population (about 700 resident) of the area. A Day-Night level of noise (DNL) of 40 to 47 dB is typical of a rural community (National Research Council 1977).

As discussed earlier, the ROD directed that research be conducted and the supersonic model used for predicting overpressures be validated. The noise study and WSMR model was initiated to satisfy this requirement. The original CDNL predictions for supersonic operations at the Valentine MOA utilized the Oceana model. That model was never calibrated with actual data.

The basic concept of the Oceana model (elliptical contours centered between setup points) is entirely reasonable. Original application of the model employed limited data and the best sonic boom modeling tools available at that time.

A comparison between the Oceana model and WSMR model based on 300 sorties per month, shows a substantial decrease in CDNL number of sonic booms heard and

Table III-3

Ambient Air Quality Standards

	Federal Primary Standard	Federal Secondary Standard
Total Suspended Particulate (TSP)		
1. 24-Hour Average	260 ug/m^3	150 ug/m^3
2. Annual Geometric Mean	75 ug/m^3	60 ug/m^3
Sulfur Dioxide (SO2)		
1. 24-Hour Average	0.14 ppm	--
2. Annual Arithmetic Mean	0.03 ppm	--
3. 3-Hour Average	--	0.50 ppm
Carbon Monoxide (CO)		
1. 8-Hour Average	9.0 ppm	9.0 ppm
2. 1-Hour Average	35.0 ppm	35.0 ppm
Ozone ($_3$)		
1. 1-Hour Average	0.12 ppm	0.12 ppm
Nitrogen Dioxide (NO_2)		
1. 24-Hour Average	--	--
2. Annual Arithmetic Mean	0.05 ppm	0.05 ppm
Lead (Pb)		
1. Calendar Quarterly Arithmetic Average	1.50 ug/m^3	1.50 ug/m^3

#ug/m^3 - data in micrograms per cubic meter
**ppm - data in parts per million by volume

Source: Office of Federal Register 1976

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1 Primary standards define levels of air quality which the U.S. Environmental Protection Agency's Administrator judges necessary to protect the public health with an adequate margin of safety.

2 Secondary standards define levels of air quality which the EPA Administrator judges necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

ppm -- parts per million
mg/m^3 -- milligrams per cubic meter
ug/m^3 -- micrograms per cubic meter

overpressure. The WSMR model showed a maximum CDNL value of 51 dB (10 dB less than the original Oceana). It resulted in 0.4 sonic booms heard at any given location per day as opposed to 2.5 from Oceana. Average peak overpressure from the WSMR model was 0.7 psf, down substantially from 2.5 psf predicted by Oceana. At Valentine where sorties may be divided into two areas of 150 each, the CDNL value would drop 0.3 dB to 48 dB and the number of sonic booms observed would be half (0.2).

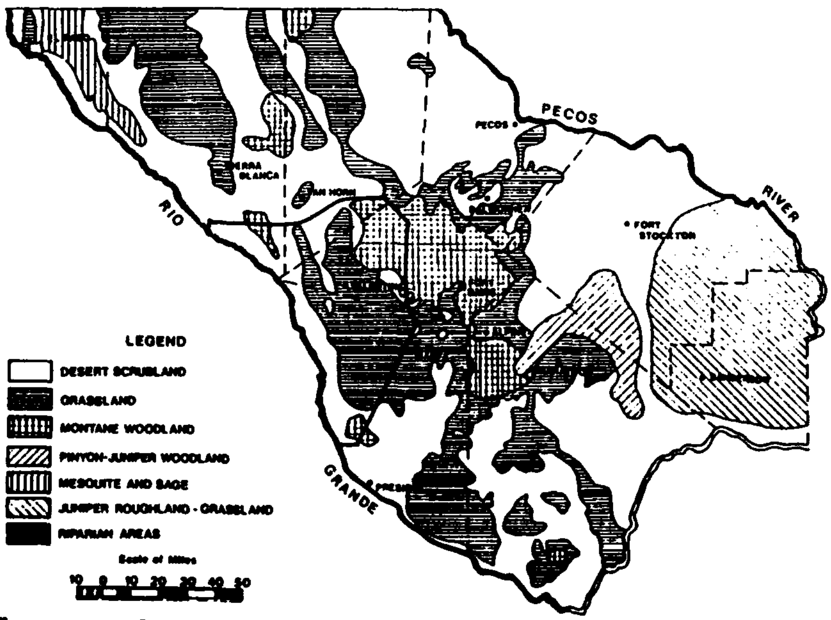
F. Biological Resources

1. Vegetation

The Valentine MOA lies entirely within the Trans-Pecos mountains and basins ecological area of Texas (Gould et al. 1969). The seven major vegetative regions as defined by Schmidly (1977) are illustrated in Figure III-5. Specific vegetation types that may be encountered include:

- Tobosa-Black Grama Grassland
- Creosotebush-Lechuguilla Shrub
- Croplands
- Grey Oak-Pinyon Pine-Alligator Juniper Parks/Woods
- Yucca-Ocotillo Shrub
- Mesquite-Saltcedar Brush Woods
- Creosotebush-Tarbush Shrub
- Creosotebush-Mesquite Shrub

Dominant vegetation in the Valentine MOA consists of three types: tobosa-black grama grassland, creosotebush-lechuguilla shrub, and grey oak-pinyon pine-alligator juniper parks/woods. Commonly associated plants with the tobosa-black grama grassland include blue grama, sideoats grama, Arizona cottontop, creosotebrush, broom snakeweed, and white thorn acacia (McMahan et al. 1984). Common associates of the creosotebrush-lechuguilla shrub type include mesquite, yucca, catclaw acacia, pricklypear cactus, black grama and tarbrush. Commonly associated plants of the grey oak-pinyon pine-alligator juniper parks/woods include Gambel's oak, mountain mahogony, pine dropseed, blue grama, pinyon ricegrass and heartleaf ground cherry. This vegetation type occurs at elevations of 5,500 to 7,500 ft. MSL primarily in the Davis Mountains.



Source: Schmidly, D.J. 1977

FIGURE III-5 Major Vegetative Regions of the Trans Pecos.

III. AFFECTED ENVIRONMENT

A. Climate

1. General

Unless otherwise noted, the climatic conditions (long-term averages) described herein are a composite of data compiled by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) at stations in Presidio and Van Horn Texas (1941-1970) and Alpine Texas (1951-1980). These cities essentially ring the Valentine MOA (Figure III-1). The climate in the area is arid sub-tropical with average total precipitation ranging from 8.61 to 14.83 inches per year. Snowfall is rare and is considered of little importance. Irrigation is required to support plant life other than desert vegetation. Winters are characterized by fair, dry weather with mild days and cool nights. Freezes occur about half the time during December and January. The lowest recorded temperatures were -7°, -2° and 4°F at Van Horn, Alpine, and Presidio, respectively. Upper summer daytime temperatures range from warm (under 95°F) at Van Horn to over 100°F at Presidio.

2. Wind

Recorded weather data at Presidio, Van Horn, and Alpine did not contain historical wind speed and direction information. However historical wind data at El Paso, Texas (150 miles to the northwest) between 1951 and 1960 provide an indication of regional wind trends. The average wind speed is nine miles per hour (MPH) from the north. The strongest winds have been in the spring averaging 11.3 MPH from the west southwest.

3. Precipitation

Annual precipitation across the Valentine MOA has ranged from, 1.64 inches at Presidio, Texas in 1956 to 27.27 inches at Van Horn, Texas in 1941. The average annual precipitation for this area is between nine and 10 inches of which about

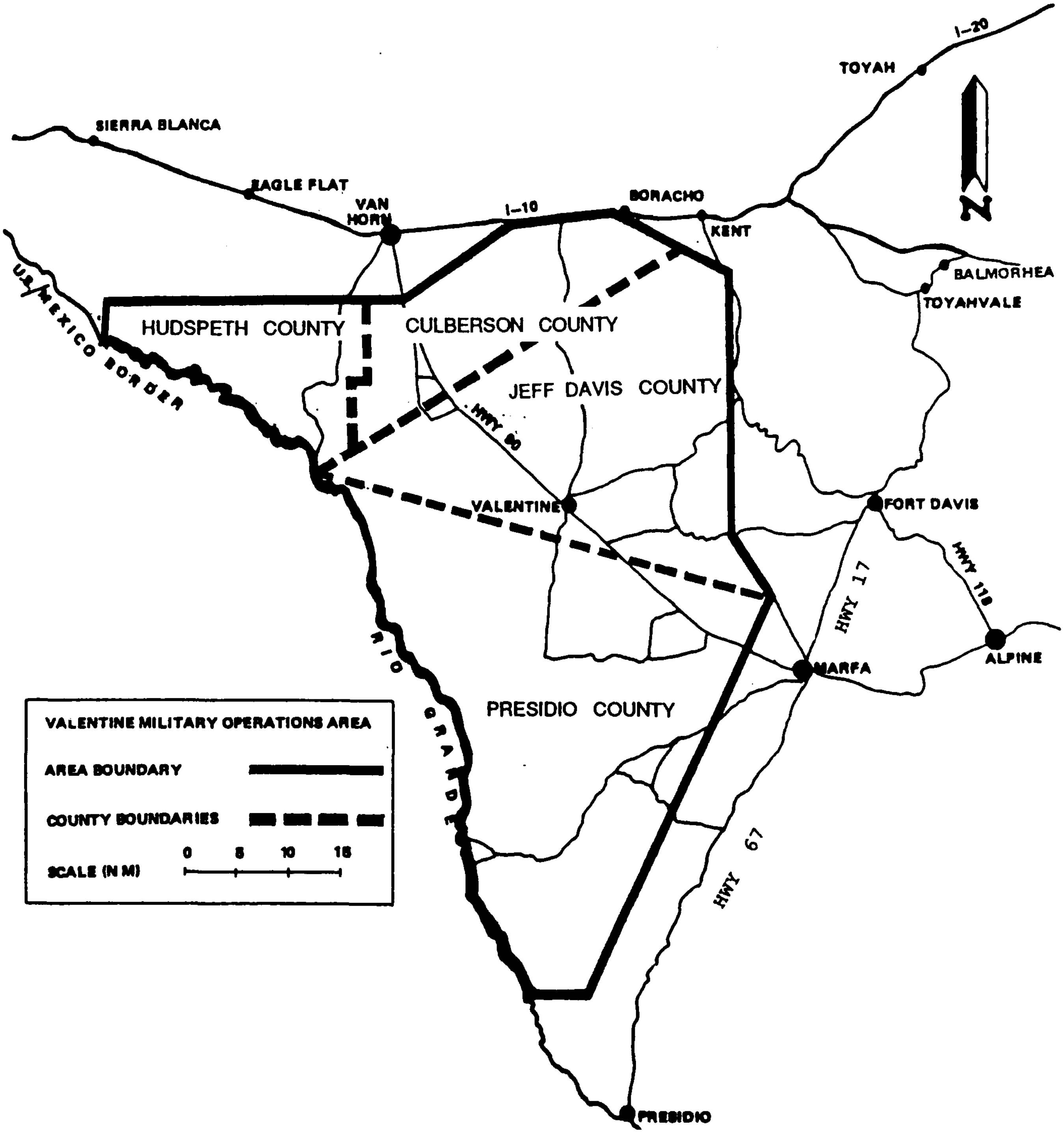


FIGURE III-1 County Boundaries and Towns in the Vicinity of the Valentine Military Operations Area

2. Reptiles and Amphibians

Numerous species of frogs, turtles, lizards, and snakes are native to the four counties containing the Valentine MOA. Table III-4 is a checklist of species reported from one or more of the counties and the MOA.

3. Fishes

Several species of fish may be found within the rivers streams and ponds of the four county area comprising the Valentine MOA. Table III-5 is a list of some of the fishes that have been reported from or presumed to occur within the MOA.

4. Birds

Many species of resident and migrating birds are found within the MOA and adjacent counties. Table III-6 lists species of birds that are considered residents in the MOA area. Other transient or migratory birds include various species of ducks, geese, cranes, osprey, phalaropes, warblers, and pipits which may temporarily inhabit or utilize the area.

5. Mammals

Table III-7 is a checklist of mammals reported from one or more of the four counties making up the Valentine MOA. The probability that these mammals could be found in the MOA is extremely high.

6. Threatened and Endangered Species

The Valentine MOA contains portions of four counties: Jeff Davis, Presidio, Hudspeth, and Culberson. Threatened and endangered species of plant, fish, reptiles, birds, and mammals may be encountered. Table III-8(a) details those species that are considered threatened and/or endangered by the State of Texas. A listing of 72 plant species that have been identified as threatened or endangered by the Texas Natural History Program is provided, along with federal

TABLE III-4

Checklist of Amphibians and Reptiles Reported in One or More Counties
(Jeff Davis, Culberson, Hudspeth or Presidio Counties)

Salamander

Ambystoma tigrinum mavortium, barred tiger salamander

Frogs and Toads

Scaphiopus bombifrons, Plains spadefoot toad
Scaphiopus couchi, Couch's spadefoot toad
Scaphiopus multiplicatus, New Mexico spadefoot toad
Bufo cognatus, Great Plains toad
Bufo debilis insidior, western green toad
Bufo punctatus, red-spotted toad
Bufo speciosus, Texas toad
Bufo woodhousei australis, southwestern Woodhouse's toad
Rana berlandieri, Rio Grande leopard frog
Rana blairi, Plains leopard frog
Rana catesbeiana, bullfrog
Gastrophryne olivacea, Great Plains narrowmouth toad
Syrrhophus suttilatus, spotted chirping frog
Hyla arenicolor, canyon treefrog

Turtles

Kinosternon flavescens flavescens, yellow mud turtle
Chrysemys picta belli, western painted turtle
Pseudemys concinna gorzugi, Zug's river cooter
Terrapene ornata luteola, desert box turtle
Trachemys scripta elegans, red-eared slider
Trionyx spiniferus emoryi, Texas spiny softshell turtle
Trachemys gaigeae, Big Bend slider
Kinosternon hirtipes murrayi, Big Bend mud turtle

Lizards

Coleonyx brevis, Texas banded gecko
Cophosaurus texanus scitulus, southwestern earless lizard
Crotaphytus collaris collaris, eastern collared lizard
Holbrookia maculata approximans, speckled earless lizard
Phrynosoma cornutum, Texas horned lizard
Phrynosoma modestum, roundtail horned lizard
Coleonyx reticulatus, reticulated gecko
Gambelia wislizeni wislezini, longnose leopard lizard
Sceloporus magister bimaculosus, twin spotted spiny lizard
Phrynosoma douglassi hernandesi, mountain shorthorned lizard
Sceloporus merriami longipunctatus, Presidio Canyon lizard

TABLE III-4
(cont'd)

Checklist of Amphibians and Reptiles Reported in One or More Counties
(Jeff Davis, Culberson, Hudspeth or Presidio Counties)

<u>Sceloporus</u> <u>merriami</u> <u>merriami</u>, Merriam's Canyon lizard
<u>Sceloporus</u> <u>poinsetti</u> <u>poinsetti</u>, crevice spiny lizard
<u>Sceloporus</u> <u>undulatus</u> <u>consobrinus</u>, Southern prairie lizard
<u>Urosaurus</u> <u>ornatus</u> <u>schmidti</u>, Big Bend Tree lizard
<u>Uta</u> <u>stansburiana</u> <u>stejnegeri</u>, desert side-blotched lizard
<u>Eumeces</u> <u>multivirgatus</u> <u>epipleurotus</u>, variable skink
<u>Eumeces</u> <u>obsoletus</u>, Great Plains skink
<u>Eumeces</u> <u>tetragrammus</u> <u>brevilineatus</u>, short-lined skink
<u>Cnemidophorus</u> <u>dixoni</u>, gray-checkered whiptail
<u>Cnemidophorus</u> <u>exsanguis</u>, Chihuahuan spotted whiptail
<u>Cnemidophorus</u> <u>septemvittatus</u>, plateau spotted whiptail
<u>Cnemidophorus</u> <u>neomexicanus</u>, New Mexico whiptail
<u>Cnemidophorus</u> <u>gularis</u> <u>gularis</u>, Texas spotted whiptail
<u>Cnemidophorus</u> <u>inornatus</u> <u>heptagrammus</u>, Trans-Pecos striped whiptail
<u>Cnemidophorus</u> <u>tesselatus</u>, Colorado checkered whiptail
<u>Cnemidophorus</u> <u>marmoratus</u>, marbled whiptail

Snakes

<u>Leptotyphlops</u> <u>dulcis</u> <u>dissectus</u>, New Mexico blind snake
<u>Leptotyphlops</u> <u>humilis</u> <u>segregus</u>, Trans-Pecos blind snake
<u>Arizona</u> <u>elegans</u> <u>elegans</u>, Kansas glossy snake
<u>Coluber</u> <u>constrictor</u> <u>mormon</u>, western yellowbelly racer
<u>Diadophis</u> <u>punctatus</u> <u>regalis</u>, regal ringneck snake
<u>Elaphe</u> <u>bairdi</u>, Baird's rat snake
<u>Elaphe</u> <u>guttata</u> <u>emoryi</u>, Great Plains rat snake
<u>Elaphe</u> <u>subocularis</u>, Trans-Pecos rat snake
<u>Gyalopion</u> <u>canum</u>, Western hooknose snake
<u>Heterodon</u> <u>nasicus</u> <u>kennerlyi</u>, Mexican hognose snake
<u>Hypsiglena</u> <u>torgnata</u> <u>jani</u>, Texas night snake
<u>Lampropeltis</u> <u>alterna</u>, gray-banded kingsnake
<u>Lampropeltis</u> <u>getulus</u> <u>splendida</u>, desert kingsnake
<u>Lampropeltis</u> <u>triangulum</u> <u>celaenops</u>, New Mexico milk snake
<u>Masticophis</u> <u>flagellum</u> <u>testaceus</u>, western coachwhip
<u>Masticophis</u> <u>taeniatus</u> <u>girardi</u>, central Texas whipsnake
<u>Nerodia</u> <u>erythrogaster</u> <u>transversa</u>, blotched water snake
<u>Pituophis</u> <u>melanoleucus</u> <u>sayi</u>, bullsnake
<u>Rhinocheilus</u> <u>lecontei</u> <u>tessellatus</u>, Texas longnose snake
<u>Salvadora</u> <u>deserticola</u>, Big Bend patchnose snake
<u>Tantilla</u> <u>rubra</u> <u>cucullata</u>, blackhood snake
<u>Crotalus</u> <u>scutulatus</u> <u>scutulatus</u>, Mojave rattlesnake
<u>Trimorphodon</u> <u>biscutatus</u> <u>vilkinsoni</u>, Texas lyre snake
<u>Salvadora</u> <u>grahamiae</u> <u>grahamiae</u>, mountain patchnose snake
<u>Sonora</u> <u>semiannulata</u> <u>semiannulata</u>, ground snake
<u>Tantilla</u> <u>hobartsmithi</u>, southwestern blackhead snake
<u>Tantilla</u> <u>nigriceps</u> <u>nigriceps</u>, Plains blackhead snake

TABLE III-4
(cont'd)

Checklist of Amphibians and Reptiles Reported in One or More Counties
(Jeff Davis, Culberson, Hudspeth or Presidio Counties)

<u>Thamnophis</u> <u>cyrtopsis</u> <u>cyrtopsis</u>, western blackneck garter
<u>Thamnophis</u> <u>marcianus</u> <u>marcianus</u>, checkered garter snake
<u>Agkistrodon</u> <u>contortrix</u> <u>pictigaster</u>, Trans-Pecos copperhead
<u>Crotalus</u> <u>atrox</u>, western diamondback rattlesnake
<u>Crotalus</u> <u>lepidus</u> <u>lepidus</u>, mottled rock rattlesnake
<u>Crotalus</u> <u>molossus</u> <u>molossus</u>, blacktail rattlesnake
<u>Crotalus</u> <u>viridis</u> <u>viridis</u>, prairie rattlesnake
<u>Sistrurus</u> <u>catenatus</u> <u>edwardsi</u>, desert Massasanga

Source: Dixon 1987

Table III-5

Fishes Reported from Hudspeth,
Culberson, Jeff Davis or Presidio Counties

Lepisosteus osseus, longnose gar
Dorosoma cepedianum, gizzard shad
Astyanax mexicanus, Mexican tetra
Campostoma ornatum, Mexican stoneroller
Agosia chrysogaster, longfin dace
Carassius auratus, goldfish
Cyprinus carpio, common carp
Dionda episcopa, roundnose minnow
Hybopsis aestivalis, speckled chub
Notropis formosus, beautiful shiner
Notropis jemezanus, Rio Grande shiner
Notropis lutrensis, red shiner
Pimephales promelas, fathead minnow
Pimephales vigilax, bullhead minnow
Carpiodes carpio, river carpsucker
Cycleptus elongatus, blue sucker
Ictalurus furcatus, blue catfish
Ictalurus punctatus, channel catfish
Pylodictis olivaris, flathead catfish
Cyprinidon elegans, Comanche springs pupfish
Cyprinidon eximius, Conchos pupfish
Gambusia affinis, mosquitofish
Morone chrysops, white bass
Lepomis cyanellus, green sunfish
Lepomis gulosus, warmouth
Lepomis macrochirus, bluegill
Lepomis megalotis, longear sunfish
Micropterus salmoides, largemouth bass
Pomoxis annualaris, white crappie

Source:

TABLE III-6

Birds Reported from the MOA Area

LEGEND:
- R - RESIDENT
- W - WINTERS
- S - SUMMERS
- T - TRANSIENT
- r - RARE SIGHTINGS
- B - BREEDS
- * - THREATENED OR ENDANGERED

	STATUS
FAMILY PHALACROCORACIDAE - Herons/Bitterns	
Green Heron	W
Snowy Egret	R
Least Bittern	S
FAMILY ARDEIDAE - Storks	
Wood Ibis or Wood Stork	R*
White-faced Ibis	R*
FAMILY ANITIDAE - Ducks	
Fulvosas Tree Duck	R
Mallard	W
Mexican Duck	R
Gadwall	W
Pintail	W
Green-Winged Teal	W
Cinnamon Teal	WB (few)
American Widgeon	Wr
Wood Duck	Rr
Lesser Scaup	W
Common Goldeneye	Rr
Bufflehead	W
Ruddy Duck	WB
Common Merganser	N
FAMILY CATHARTIDAE - American Vultures	
Turkey Vultures	B

TABLE III-6
(cont')

Birds Reported from the MOA Area

FAMILY <u>ACCIPITRIDAE</u> - Bird Hawks, Buzzard Hawks, Eagles, Harriers

Cooper's Hawk	WB
Red-Tailed Hawk	R
Swainson's Hawk	Wr
Zone-Tailed Hawk	S*
Ferruginous Hawk	W
Harris' Hawk	R
Black Hawk	Rr*
Golden Eagle	R(few)
Bald Eagle	Wr*
Marsh Hawk	R
Gray Hawk	Rr*

FAMILY <u>FALCONIDAE</u> - Caracaras, Falcons

Peregrine Falcon	Rr*
Aplomado Falcon	Rr*
Sparrow Hawk	RB

FAMILY <u>PHASIANIDAE</u> - Quails, Partriges, Pheasants

Bobwhite	R
Scaled Quail	R
Gamble's Quail	R
Harlequin Quail	R

FAMILY <u>MELEAGRIDIDAE</u> - Turkeys

Turkey	R

FAMILY <u>GRUIDAE</u> - Cranes

Sandhill Crane	W
Whooping Crane	T

FAMILY <u>RALLIDAE</u> - Rails, Gallinules, Coots

Sora	W
American Coot	R
Killdeer	R

TABLE III-6
(cont'd)

Birds Reported from the MOA Area

FAMILY CHARADRIIDAE - Plovers

Mountain Plover	R

FAMILY SCOLOPACIDAE - Woodcocks, Snipes, Sandpipers

Common Snipe	W
Solitary Sandpiper	T
Least Sandpiper	W
Western Sandpiper	W

FAMILY RECURVIROSTRIDAE - Avocets, Stilts

American Avocet	B
Black-Necked Stilt	S

FAMILY LARIDAE - Terns

Interior Least Tern	S*

FAMILY COLUMBIDAE - Pigeons, Doves

Band-Tailed Pigeon	R
Domestic Pigeon	R
White-Winged Dove	S
Mourning Dove	R
Inca Dove	R

FAMILY CUCULIDAE - Cuckoos, Roadrunners, Anis

Yellow-Billed Cuckoo	S
Roadrunner	R

FAMILY STRIGIDAE - Owls

Screech Owl	R
Flammulated Owl	S
Great-Horned Owl	R
Burrowing Owl	WB
Spotted Owl	Rr

TABLE III-6
(cont'd)

Birds Reported from the MOA Area

FAMILY CAPRIMULGIDAE - Goatsuckers

Poor-Will	S
Common Nighthawk	S
Lesser Nighthawk	S

FAMILY APODIDAE - Swifts

White-Throated Swift	R

FAMILY TROCHILIDAE - Hummingbirds

Black-Channed Hummingbird	S
Broad-Tailed Hummingbird	S
Broad-Billed Hummingbird	Sr

FAMILY PICIDAE - Woodpeckers

Red-Shafted Flicker	WB
Acorn Woodpecker	R
Lewis Woodpecker	Rare Visitor
Yellow-Bellied Sapsucker	S
Downy Woodpecker	Wr
Ladder-Backed Woodpecker	W

FAMILY TYRANNIDAE - Tyrant Flycatchers

Western Kingbird	B
Cassin's Kingbird	B
Scissor-Tailed Flycatcher	R
Ash-Throated Flycatcher	S
Black Phoebe	R
Say's Phoebe	R
Trail's Flycatcher	S
Western Flycatcher	S
Western Wood Pewee	S

FAMILY ALAUDIDAE - Larks

Horned Lark	B

TABLE III-6
(cont'd)

Birds Reported from the MOA Area

FAMILY HURUNDINIDAE - Swallows	
Bank Swallow	R
FAMILY CORVIDAE - Jays, Magpies, Crows	
Blue Jay	R
Steller's Jay	R
Scrub Jay	R
Common Raven	R
White-Necked Raven	R
Pinon Jay	R
FAMILY PARIDAE - Titmice, Verdins, Bushtits	
Mountain Chickadee	R
Black-Crested Titmouse	R
Plain Titmouse	W
Verdin	R
Common Bushtit	R
Black-Eared Bushtit	R
FAMILY SITTIDAE - Nuthatches	
White Breasted Nuthatch	R
Pigmy Nuthatch	R
FAMILY CERTHIIDAE - Creepers	
Brown Creeper	W
FAMILY TROGLODYTIDAE - Wrens	
House Wren	B
Winter Wren	W
Bewick's Wren	R
Cactus Wren	R
Canon Wren	R
Rock Wren	R

TABLE III-6
(cont'd)

Birds Reported from the MOA Area

FAMILY MIMIDAE - Mockingbirds, Thrashers

Mockingbird	R
Curve-Billed Thrasher	R
Crissal Thrasher	R
Sage Thrasher	W

FAMILY TURDIDAE - Thrushes, Bluebirds, Solitaires

Robin	W
Hermit Thrush	B
Western Bluebird	W
Mountain Bluebird	W

FAMILY SYLVIIDAE - Gnatcatchers, Kinglets

Black-Tailed Gnatcatcher	R
Golden-Crowned Kinglet	W

FAMILY BOMBYCILLIDAE - Waxwings

Cedar Waxwing	N

FAMILY PTILOGONATIDAE - Sicky Flycatcher

Phainoperla	R

FAMILY LAWIIDAE - Shrikes

Loggerhead Shrike	W

FAMILY STURNIDAE - Starlings

Starling	W

FAMILY VIREONIDAE - Vireos

Black-Capped Vireo	S*
Hutton's Vireo	R
Gray Vireo	S
Solitary Vireo	B
Bell's Vireo	S

TABLE III-6
(cont'd)

Birds Reported from the MOA Area

FAMILY PARULIDAE - Warblers

Virginiais	S
Townsend's Warbler	S
Common Yellowthroat	S

FAMILY PLOCEIDAE - Weaver Finches

House Sparrow	R

FAMILY ICTERIDAE - Meadowlarks, Blackbirds, Orioles

Eastern Meadowlark	R
Western Meadowlark	R
Yellow-headed Blackbird	S
Redwinged Blackbird	R
Brewer's Blackbird	S
Orchard Oriole	S
Hooded Oriole	B
Scott's Oriole	S

FAMILY THRAUPIDAE - Tanagers

Western Tanager	B
Hepatic Tanager	B

FAMILY FRINGILLIDAE - Grosbeaks, Finches, Sparrows, Buntings

Cardinal	R
Pyrrhuloxia	R
Black-Headed Grosbeak	B
Varied Bunting	S
Painted Bunting	S
Cassin's Finch	W
House Finch	R
American Goldfinch	W
Lesser Goldfinch	R
Rufous-sided Towhee	B
Baird's Sparrow	W
Vesper Sparrow	W
Lark Sparrow	R
Rufous-crowed Sparrow	R

TABLE III-6
(cont'd)

Birds Reported from the MOA Area

Cassin's Sparrow	S
Black Throated Sparrow	R
Sage Sparrow	W
Chipping Sparrow	WB
Clay-colored Sparrow	W
Brewer's Sparrow	W
Black-Chinned Sparrow	R
White-Crowned Sparrow	W
Lincoln's Sparrow	W
Song Sparrow	W
McCown's Longspur	W
Oregon Junco	W
Gray-headed Junco	W

Source:

TABLE III-7

Checklist of Mammals Reported from One or More Counties
(Jeff Davis, Culberson, Hudspeth or Presidio Counties)

Habitat type: D = Desert
G = Grassland
M = Mountain
R = Riparian

Order Insectivora (Shrews and Moles)

Family Soricidae
Notiosorex crawfordi (desert shrew), D (rare)
Family Talpidae
Scalopsus aquaticus (eastern mole), R (rare)

Order Chiroptera (Bats)

Family Mormoopidae
Mormoops megalophylla (ghost-faced bat), D, G
Family Phyllostomatidae
Leptonycteris nivalis (Mexican long-nosed bat), G, M
Family Vespertilionidae
Myotis lucifugus (little brown myotis), M (rare)
Myotis yumanensis (Yuma myotis), D, G
Myotis velifer (cave myotis), D, G
Myotis thysanodes (fringed myotis), G, M
Myotis volans (long-legged myotis), M
Myotis californicus (California myotis), D, G
Myotis leibii (small-footed myotis), G, M
Lasionycteris noctivagans (silver-haired bat), M, R (rare)
Lasiurus borealis (red bat), R, M
Lasiurus cinereus (hoary bat), G, M, R (common)
Pipistrellus hesperus (Western pipistrelle), D, G (common)
Eptesicus fuscus (big brown bat), G, M
Plecotus townsendii (Townsend's big-eared bat), D, G
Antrozous pallidus (pallid bat), D, G (common)
Family Molossidae
Tadarida brasiliensis (Brazilian free-tailed bat), D, G (common)
Tadarida macrotis (big free-tailed bat), D, M
Eumops perotis (western mastiff bat), D

Order Lagomorpha (Rabbits and Hares)

Family Leporidae
Sylvilagus floridanus (eastern cottontail), G, M
Sylvilagus audubonii (desert cottontail), D, G, R
Lepus californicus (black-tailed jackrabbit), D, G

TABLE III-7
(cont')

Checklist of Mammals Reported from One or More Counties
(Jeff Davis, Culberson, Hudspeth or Presidio Counties)

Order Rodentia (Rodents)

Family Sciuridae
- Eutamias canipes (grey-footed chipmunk), M (rare)
- Ammospermophilus interpes (Texas antelope squirrel), D, G, M
- Spermophilus mexicanus (Mexican ground squirrel), D, G (common)
- Spermophilus spilosoma (spotted ground squirrel), D
- Spermophilus variegatus (rock squirrel), D, G, M

Family Geomyidae
- Thomomys bottae (Botta's pocket gopher), D, G, M
- Geomys arenarius (desert pocket gopher), D, R (rare)
- Pappogeomys castanops (yellow-faced pocket gopher), D, G, R

Family Heteromyidae
- Perognathus flavus (silky pocket mouse), D, G (common)
- Perognathus hispidus (hispid pocket mouse), G
- Perognathus penicillatus (desert pocket mouse), D, R (common)
- Perognathus intermedius (rock pocket mouse), D, G
- Perognathus nelsoni (Nelson's pocket mouse), D, G
- Dipodomys spectabilis (banner-tailed kangaroo rat), D, G
- Dipodomys ordii (Ord's kangaroo rat), D, G
- Dipodomys merriami (Merriam's kangaroo rat), D, G (common)

Family Cricetidae
- Reithrodontomys fulvescens (fulvuns harvest mouse), D, G (rare)
- Reithrodontomys montanus (plains harvest mouse), G (rare)
- Reithrodontomys megalotis (western harvest mouse), G
- Peromyscus eremicus (cactus mouse), D, G
- Peromyscus maniculatus (deer mouse), D, G
- Peromyscus leucopus (white-footed mouse), G, R
- Peromyscus boylii (brush mouse), M
- Peromyscus pectoralis (white-ankled mouse), G, M
- Peromyscus truei (Pinon mouse), M (rare)
- Peromyscus difficilis (rock mouse), M (rare)
- Onychomys torridus (southern grasshopper mouse), D, G
- Sigmodon hispidus (hispid cotton rat), G, R (common)
- Neotoma micropus (Southern plains wood rat), D, G
- Neotoma albigula (white-throated wood rat), G, M
- Neotoma mexicana (Mexican wood rat), M

Family Erethizontidae
- Erethizon dorsatum (porcupine), M, G

Order Carnivora (Carnivores)

Family Canidae
- Canis latrans (coyote), D, G, M, R
- Vulpes macrotis (kit fox), D (rare)
- Urocyon cinereoargenteus (gray fox), G, M

TABLE III-7
(cont')

Checklist of Mammals Reported from One or More Counties
(Jeff Davis, Culberson, Hudspeth or Presidio Counties)

Family Procyonidae
- *Bassariscus astutus* (ringtail), D, G, M, R
- *Procyon lotor* (racoon), D, G, M, R (common)

Family Mustelidae
- *Mustela frenata* (long-tailed weasel), G (rare)
- *Taxidea taxus* (badger), D, G (rare)
- *Spilogale gracilis* (western spotted skunk), D, G (rare)
- *Mephitis mephitis* (striped skunk), G, M, R (common)
- *Mephitis macroura* (hooded skunk), G, M (rare)
- *Conepatus mesoleucus* (hognosed skunk), D, G, M (rare)

Family Felidae
- *Felis concolor* (mountain lion), M, R (rare)
- *Felis rufus* (bobcat), G, M, R (uncommon)

Order Artiodactyla (Even-toed ungulates)

Family Tayassuidae
- *Dicotyles tajacu* (collared peccary), D, G (common)

Family Cervidae
- *Odocoileus hemionus* (mule deer), D, G (common)
- *Odocoileus virginianus* (white-tailed deer), G, M (abundant)

Family Antilocapridae
- *Antilocapra americana* (pronghorn), G (common)

Source: Schmidly D.J., 1977

Table III-8(a)

Texas Threatened and Endangered Species
in the Valentine MOA

	Jeff Davis	Presidio	Hudspeth	Culberson
Big Bend mud turtle (*Kinosternon hirtipes murrayi*)		1*		
Comanche Springs pupfish (*Cyprinodon elegans*)	1*			
Pecos Gambusia (*Gambusia nobilis*)	1*			
Aplomado falcon (*Falco femoralis*)	3*			
American Peregrine falcon (*Falco peregrinus anatum*)	1*	1*	2*	1*
Interior least tern (*Sterna antillarum athalassos*)	1*	3*	3*	3*
Bald eagle (*Haliaeetus leucocephalus*)	1*	1*	2*	1*
Black bear (*Ursus americanus*)	2*		1*	1*
Blue sucker (*Cycleptus elongatus*)	3**	1**	3**	
Rio Grande chub (*Gila pandora*)	1**			
Mexican stoneroller (*Campostoma ornatum*)		1**		
Chihuahua shiner (*Notropis chihuahua*)		1**		
Conchos pupfish (*Cyprinodon eximius*)		1**		
Texas Lyre snake (*Trimorphodon biscutatus vilkinsonii*)	3**	1**	1**	3**
Big Bend blackhead snake (*Tantilla rubra*)	1**	1**	2**	2**
Texas horned liard (*Phrynosoma cornutum*)	1**	1**	1**	1**
Mountain short horned lizard (*Phrynosoma douglassii hernandesi*)	1**	3**	1**	1**
Reticulated gecko (*Coleonyx reticulatus*)		1**		
Black-capped vireo (*Vireo atricapillus*)	3**	3**		
Wood stork (*Mycteria americana*)	2**	2**	2**	3**
American swallow-tailed kite (*Elanoides forficatus*)	1**	2**	3**	3**
White-faced ibis (*Plegadis chihi*)	1**	2**	1**	1**

Table III-8(a) (cont'd)

Texas Threatened and Endangered Species
in the Valentine MOA

	Jeff Davis	Presidio	Hudspeth	Culberson
Zone-tailed hawk (Buteo albonotatus)	1**	1**	2**	1**
Gray haw (Buteo nitidus)	1**	2**	2**	2**
Common black hawk (Buteogallus anthracinus)	1**	2**	2**	3**
Spotted bat (Euderma maculatum)	3**	2**	2**	3**

1 - Confirmed species - verified recent occurrence
2 - Probable species - unconfirmed but within general distribution pattern
3 - Possible species - unconfirmed but at periphery of known distribution
* - Endangered
** - Threatened

Source: Texas Parks and Wildlife Department 1987

status and state ranking, in Appendix A. The species of greatest Federal concern are Lloyds hedgehog cactus, (Echinocereus lloydii), listed as endangered, and McKittrick pennyroyal, (Hedeoma apiculatum), listed as threatened, as shown in Table III-8(b). Lloyd's hedgehog cactus is also listed as endangered in Texas. Some such specimens have been reported to occur in Presidio County. McKittrick's pennyroyal is listed by Texas as threatened and occurs in Culberson County.

G. Cultural/Historical Resources

1. Status of Cultural/Historical Research

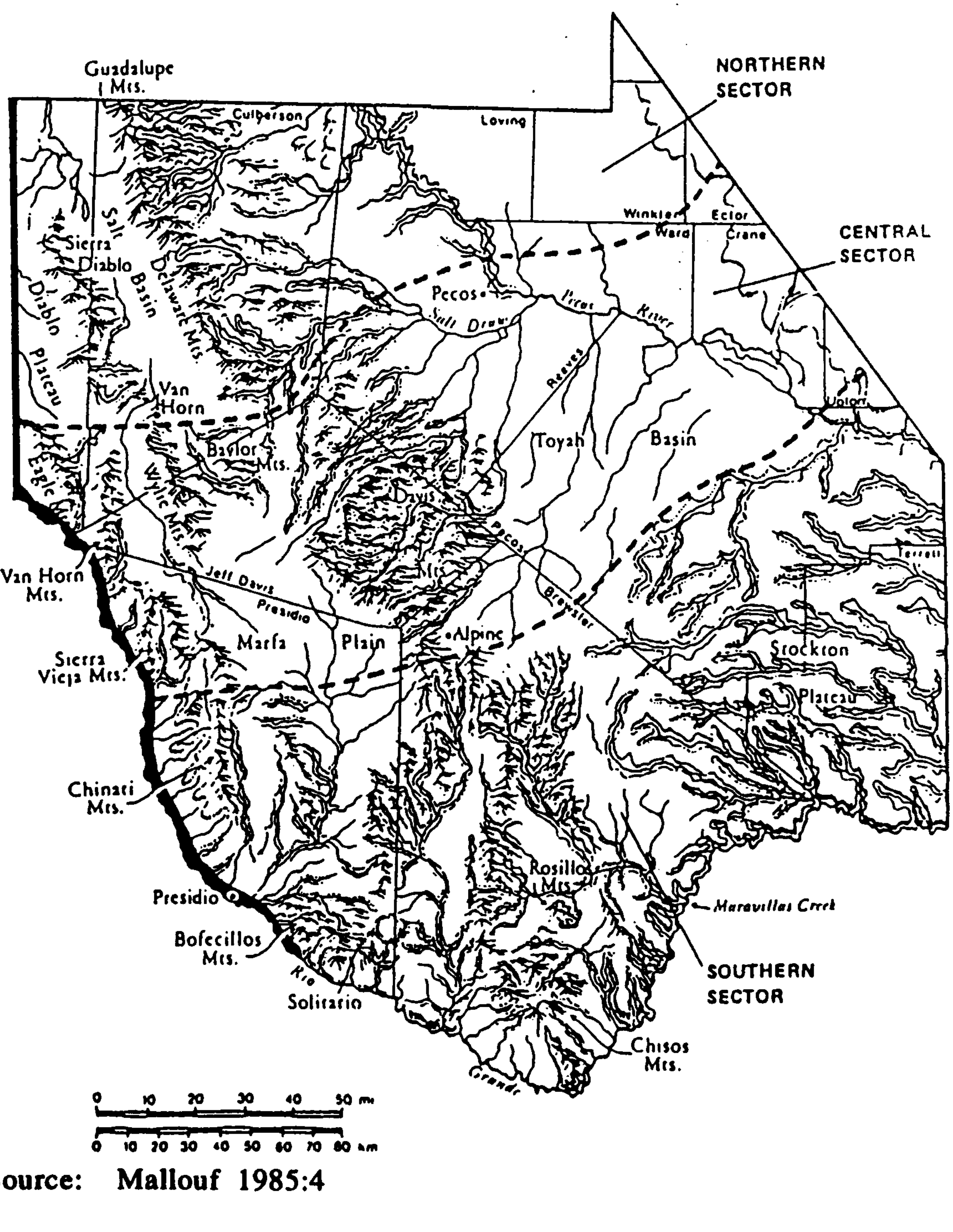
Archeological interest in the eastern Trans-Pecos region (Mallouf 1985) was initiated as early as 1895, but the initial syntheses (Sayles 1935; Kelley, Campbell, and Lehmer 1940; Lehmer 1948) for the Trans-Pecos region (Figure III-6) were generated from the excavation of rockshelters and caves in the 1920s and 1930s (Smith 1932, 1933, 1934, 1938; Smith and Kelley 1933; Coffin 1932; Sayles 1935, 1941; Holden 1938, 1941; Howard 1932; Mera 1938). This 1940 framework was re-evaluated by subsequent reviews of Trans-Pecos archeology (Suhm, Krieger, and Jelks 1954; Lehmer 1958), but the basic framework remained unchanged. A subsequent synthesis (Marmaduke 1978) focused on an ecological explanation of the prehistoric adaptations rather than a reformulation of the cultural-historical framework. More recently, Mallouf (1985) has reviewed the archeological data base of the eastern Trans-Pecos in order to identify the strengths and weaknesses in the data base. His review indicates that the antiquarian nature of many of the early investigations and the limited scope of the more recent investigations have contributed to the poor state of knowledge concerning the archeology of the Trans-Pecos region. The primary research need for the region is the establishment of a sound chronological framework and an understanding of the relationships between population densities, settlement-subsistence patterns, extraregional trade patterns, and the changing Holocene environment. Of the three regional sectors, the central one which includes the Valentine MOA, is most in need of basic research (Mallouf 1985).

TABLE III-8(b)

Federally Listed, Proposed, or Category 1 Candidate Species

Jeff Davis County	-	American peregrine falcon (Falco peregrinus anatum) (E)* Bald eagle (Haliaeetus leucocephalus) (E) - 1988 winter survey Comanche Springs pupfish (Cyprinodon elegans) (E) Pondweed sp. - (Potamogeton clystocarpos) - Category 1
Hudspeth County	-	American peregrine falcon (Falco peregrinus anatum) (E) Lloyd's hedgehog cactus (Echinocereus lloydii) (E) Sneed pincushion cactus (Corypantha sneedii var. sneedii) (E)
Culberson County	-	American peregrine falcon (Falco peregrinus anatum) (E) Lloyd's hedgehog cactus (Echinocereus lloydii) (E) Sneed pincushion cactus (Corypantha sneedii var. sneedii) (E) Gypsum wild buckwheat (Eriogonum gypsophylum) (T) - Possibly occurs in county McKittrick pennyroyal (Hedeoma apiculatum) (T) - Critical habitat designated in three areas in the Guadalupe Mountains
Presidio County	-	American peregrine falcon (Falco peregrinus anatum) (E) Mexican long-nosed bat (Leptonycteris nivalis) (E) - Possibly occurs in county Cory cactus sp. (Coryphantha strobiliformis var. durispina) - Category 1 Lloyd's mariposa cactus (Neolloydia mariposensis) (T) Hinkley's oak (Quercus hinckleyi) (T)

* T = Threatened
E = Endangered



Source: Mallouf 1985:4

FIGURE III-6 Map of the Eastern Trans-Pecos Region; Northern, Central and Southern Sectors are Noted

2. Known Archeological and Historic Properties

Within the Valentine MOA a wide variety of archeological resources has been recorded. Representative site types of the prehistoric period include rockshelters, burned rock middens, ring middens, lithic scatters, hearthfields, buried alluvial sites, caches, quarries, and rock art sites. Of the 932 sites presently recorded for Hudspeth, Culberson, Jeff Davis, and Presidio Counties, only 81 are located within the Valentine MOA (Texas Archeological Research Laboratory files). The most visible of these sites are six rockshelters and the five rock art sites. Discussions with the State Archeologist and local archeologists, however, indicate that hundreds of sites are known but remain to be formally recorded. Rockshelters and rock art sites are well represented within this group, and a number are located within the primary flight area between Van Horn and Valentine.

A total of 22 recorded sites of the historic period are also present within the Valentine MOA. Along the Rio Grande valley adobe structures of the late nineteenth and early twentieth centuries remain in various states of preservation. Farmsteads, homes, cotton gins, churches, stage stations, and forts are represented. Cemeteries, smelters, windmills, and mining operations are also common within the area. Although many of these sites are potentially eligible for the National Register of Historic Places, most have not been adequately documented. Even though the survey data are quite limited, it appears that standing structures are not well represented within the proposed flight ellipses.

At the present, there is only one site, the Lobo Valley Petroglyph Site (41CU9), within the Valentine MOA which is listed on the National Register of Historic Places. Numerous sites, such as the many rockshelters in the mountains of the region and the early historic sites mentioned above are potentially eligible, however. Van Horn Wells, an early stage station, is the only site within the MOA which is presently designated as a Texas Historic Landmark.

H. Socioeconomic Resources

1. Population

In the period 1960 to 1980, the population of Jeff Davis County declined overall, but showed a vigorous growth period in 1976 and 1977. Since 1980, the population in the county has increased by 3 percent, nearly matching growth in the previous period. The population growth, however has not been evenly distributed throughout the age groups. Peak population change occurred in the 20 to 35-year age groups and 65 to 75-year age groups. The groups showing little increase in the period 1980 to 1985 were the 35 to 65-year age groups, a large portion of the productive ages. The increases in the older age groups may be attributable to the increase in the attractiveness of the area to retirement living. The increases observed in the younger age groups may be attributable to employment in the ranching, retailing, and service areas of the economy.

The population trends of the area is detailed in Figure III-7. The performance for each county represented in the MOA is presented in Figures III-8 through III-11. Population projections for each county located within the MOA are provided in Figures III-12 through III-15.

Projections available from the West Texas Council of Governments in El Paso, Texas indicate a growth trend of 45 percent for Jeff Davis County. It is expected that such growth will primarily occur in the Fort Davis area, with a smaller expectation of growth in the Valentine area.

2. Employment

Between 1970 and 1980, Jeff Davis County experienced a net decline of approximately 4 percent in its labor force and employment. Since that time, the total number of employees has increased by only 10 workers. The increase in the 20 to 30-year age groups in the area had been attributed to employment in local ranching and railroad. The railroad, however, moved its operation from Valentine to El Paso in 1987, producing short-term employment fluctuations that were

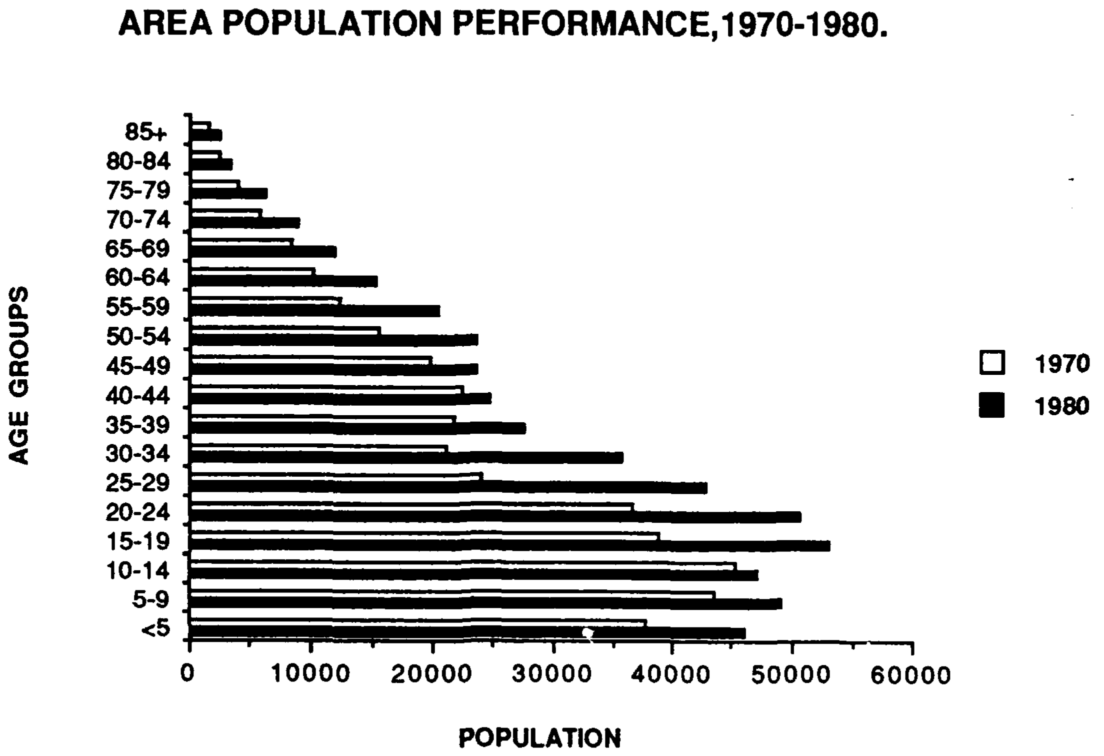


FIGURE III-7 Area Population Performance

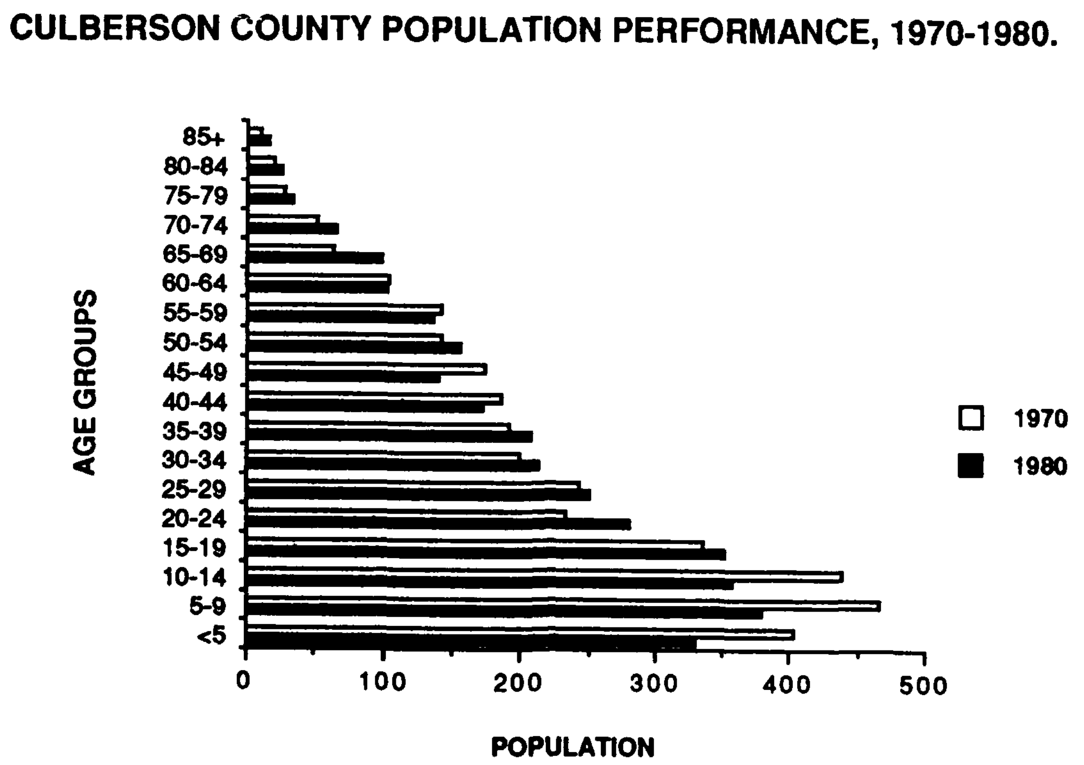


FIGURE III-8 Culberson County Population Performance

HUDSPETH COUNTY POPULATION PERFORMANCE,1970-1980.

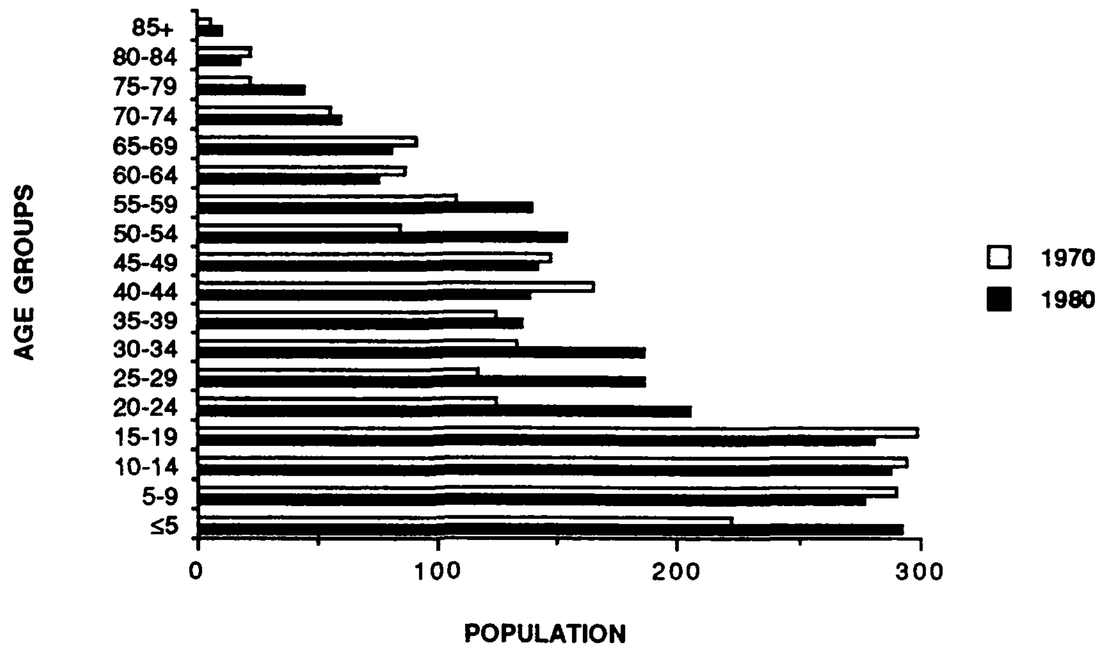


FIGURE III-9 Hudspeth County Population Performance

JEFF DAVIS COUNTY POPULATION PERFORMANCE,1970-1980.

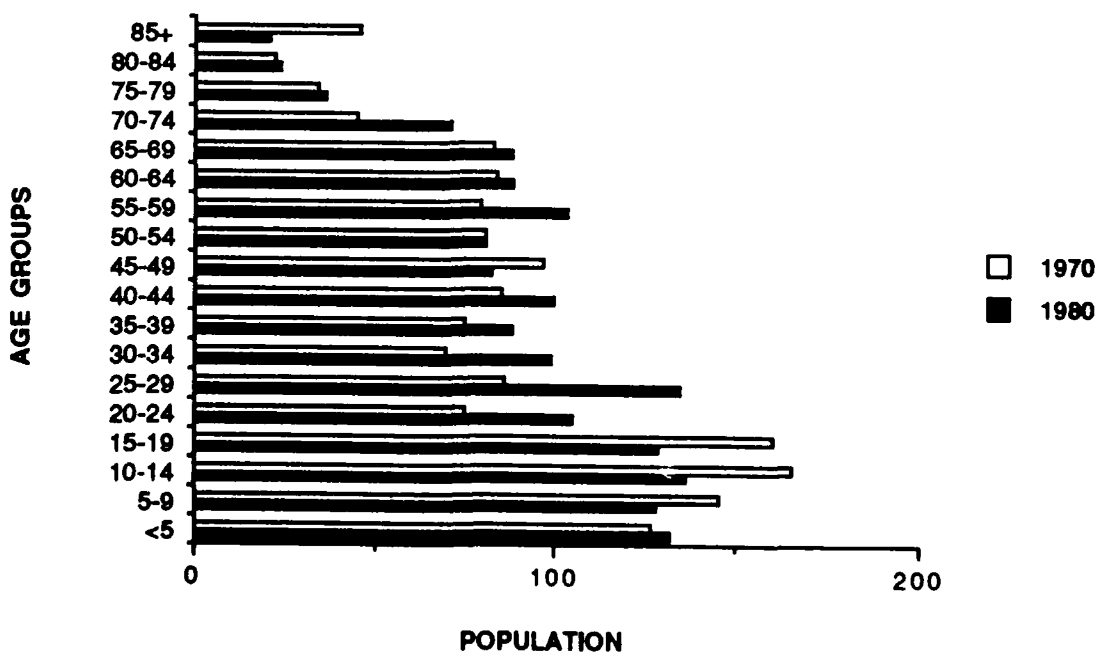


FIGURE III-10 Jeff Davis County Population Performance

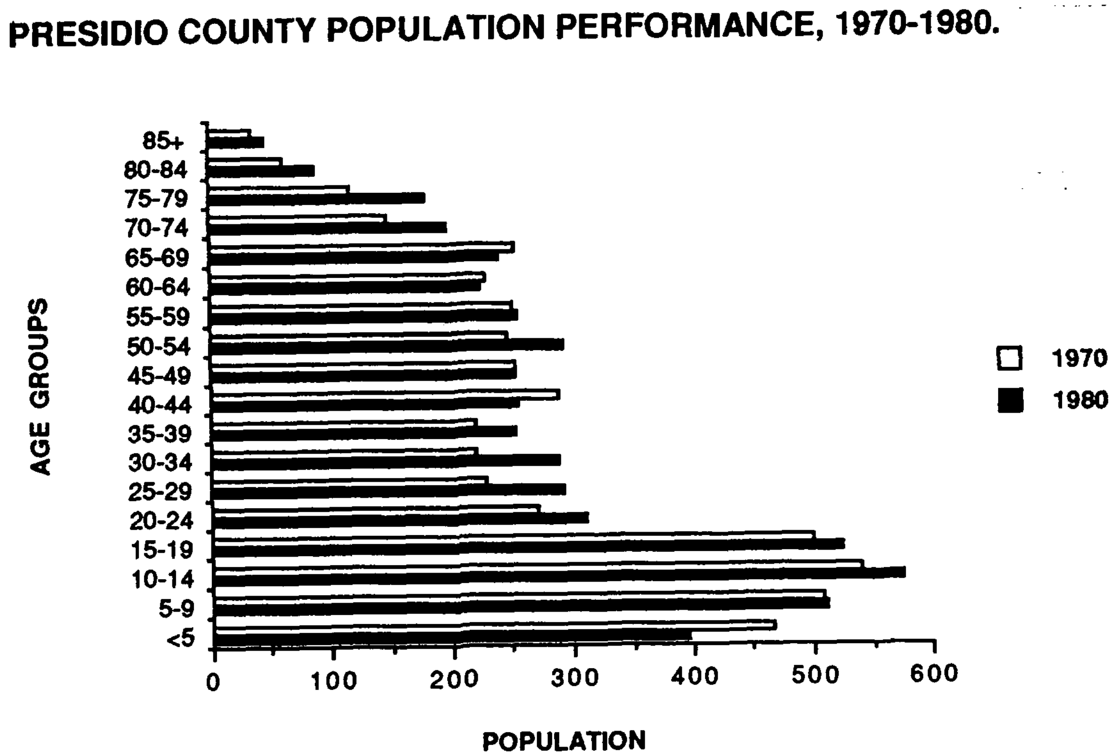


FIGURE III-11 Presidio County Population Performance

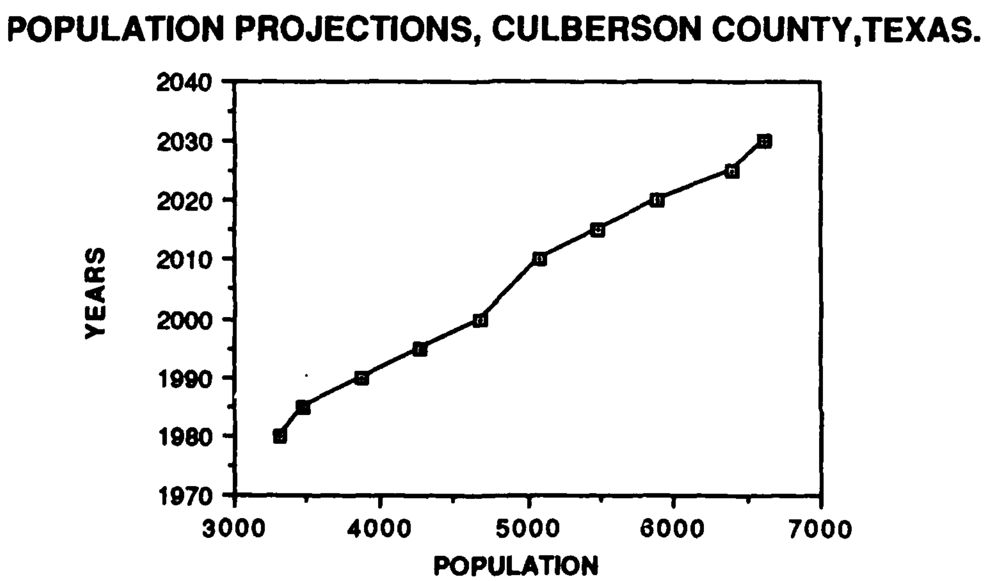


FIGURE III-12 Population Projections, Culberson County

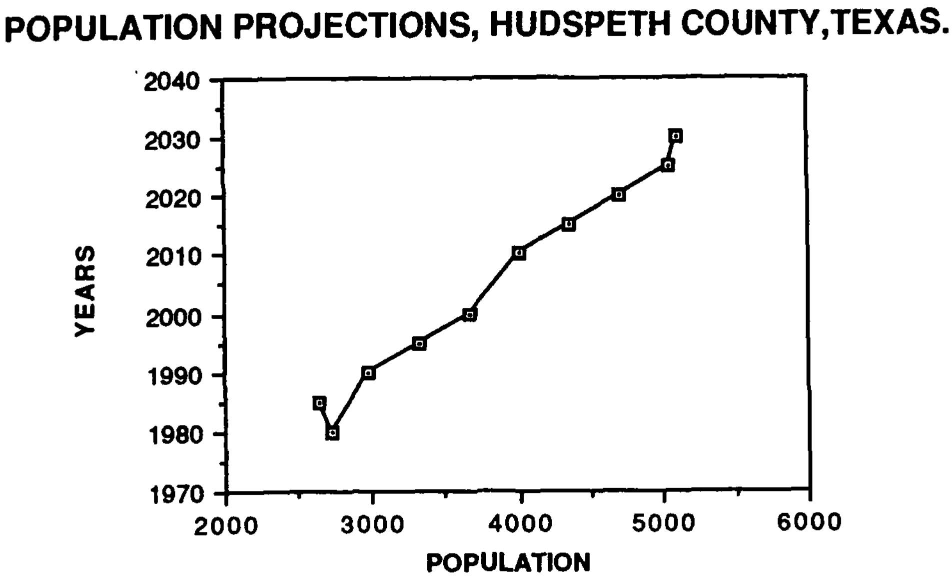


FIGURE III-13 Population Projections, Hudspeth County

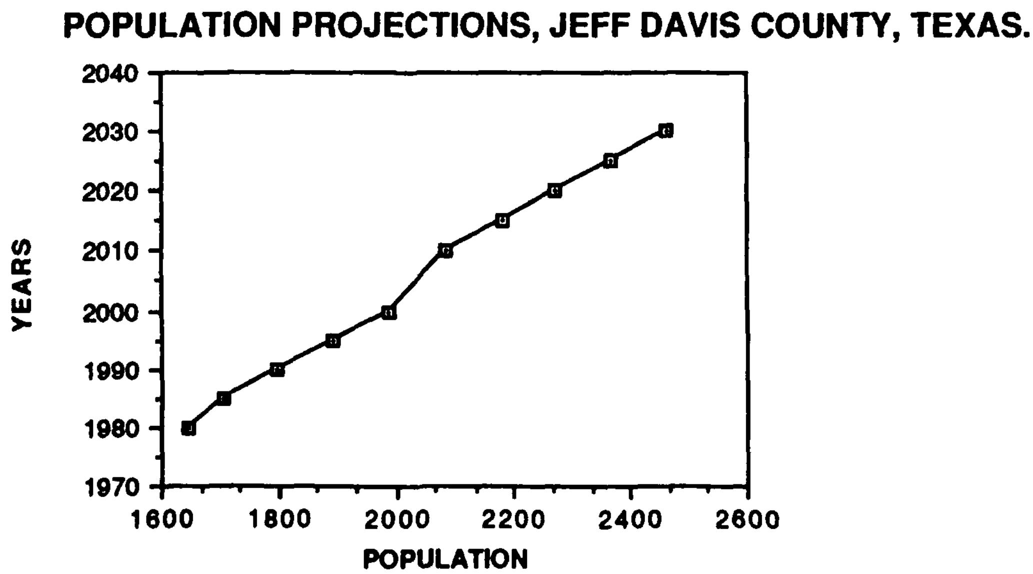


FIGURE III-14 Population Projections, Jeff Davis County

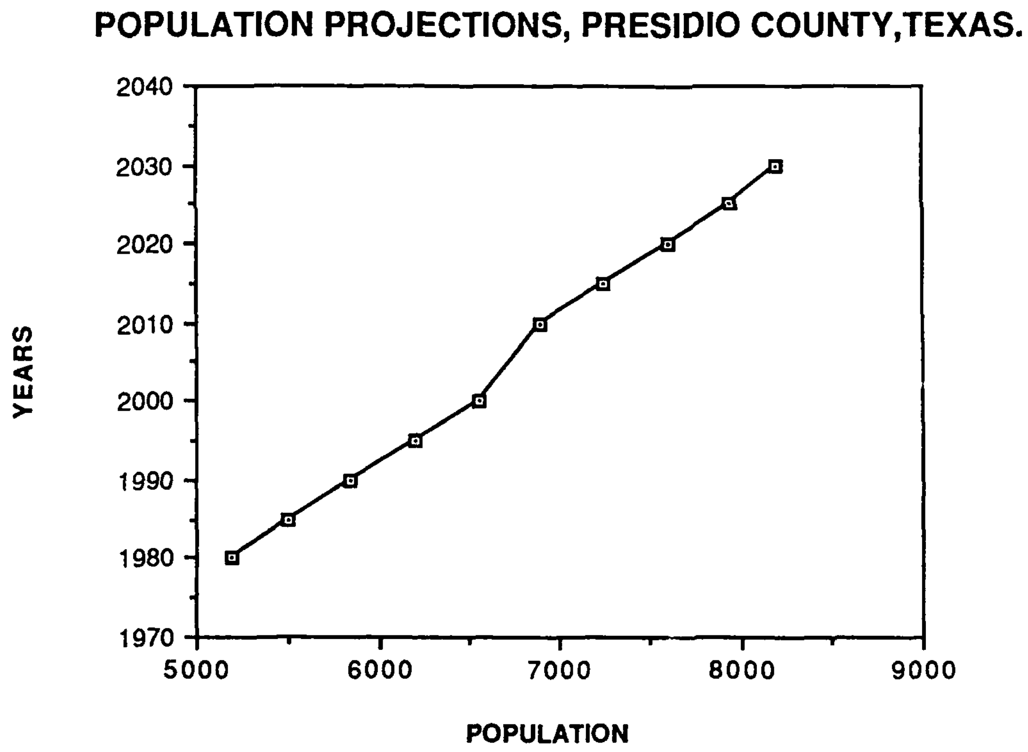


FIGURE III-15 Population Projections, Presidio County

primarily absorbed by the local job market. The oil business that was once prominent in West Texas has suffered in recent years and has been slow to recover. That segment of the labor force is extremely impacted, but employment in the Valentine area remains stable in the ranching and agriculture segments. Since 1980, local employment in Fort Davis has been essentially stable with a tendency to develop local retail and services segments.

3. Personal Income

Personal income determinations for areas of small population are difficult to determine due in part to disclosure rulings and the lack of a current census study. In the period of 1970 to 1980, personal income in Jeff Davis County grew by nearly 35 percent at a time of extreme inflation. Per capita income in that period increased by approximately 45 percent. By 1980, the population of the county had increased only 336 persons over 1970. By 1985, the county added only 56 additional persons to its population, only 10 employees to its labor force, and only eight new businesses. The intervening years have been marked with stability, producing little personal income growth. The removal of the railroad operations, switching and a labor crew rest camp, from Valentine, lack of growth in employment, and a low level of new business development are a hallmark of those years. It is not expected that personal income levels will have changed significantly. Local farming, ranching, and retail/service businesses have apparently absorbed employment losses, and personal income levels remain largely unchanged.

In the 1980 assessment, the inability of area residents to increase their personal income in the face of rising living costs was identified. The report noted an apparent "losing ground" position with respect to personal income levels. It is apparent that those levels have changed little over the intervening years. Interviews with local sources indicated the climate of income stability is continuing. Recreation and tourism spending is continuing to show promise in the Fort Davis area, but the Valentine area remains marked by stability in personal income.

4. Retail Trade

Between 1977 and 1980, the level of retail trade, as evidenced by levels of new establishments created, indicated overall stability for the period. A net loss of a single establishment was experienced. Since 1980, only a single new retail establishment was developed. However, the total retail payroll since 1980 has increased from $168,000 to $368,000 in 1985, an approximate 120 percent increase. Only eight new retail employees were reported during that period. Retail economy in the county has become more viable, and the level of retail trade in the county has become a significant segment of the local economy. Businesses in the county have apparently developed and broadened their scope, the volume, and their service and product delivery. In the face of small population increases, this increase is even more significant.

5. Assessed Valuation

Of four control MOAs examined, assessed real property valuation increased, suggesting net improvements to the tax base. The Jeff Davis Appraisal District was created in 1982, and interviews with its staff suggested there was result in growth for the county.

The large growth in assessed valuation between 1982 and 1984 was possible due to a revaluation or changes in taxation. The assessed valuation for the county has been stable since 1984 at approximately $80,000,000. The 1987 assessed valuation for the county is $81,382,136, a reduction over the 1986 level, but consistent with the above data.

6. Real Estate Development

During the late 1970s and early 1980s, the area experienced a trend toward real estate developments catering to retirement and second home markets (USAF 1981). This trend has played a large part in the development of the county, particularly in the Fort Davis area. Most of the available land in the area is rural range land. The large retirement and second home developments have primarily occupied

the scenic mountain areas of the county surrounding the Fort Davis area. The USAF (1981) listed the following developments as being of significant residential/retirement areas within or near the Valentine MOA:

Davis Mountain Resort
Crow's Nest
Apache Pines
Green Valley
Hi Chaparral
Gulf Coast Development
Bloys Camp Meeting

Interviews with local realtors indicate that these developments have been almost entirely absorbed and sold, although much land remains undeveloped by individual owners. Since that time, Olympia Crossing, South Fort Davis and Green Valley residential/retirement areas have commenced construction and are currently being developed. The climate, natural beauty, and the seclusion of the Fort Davis area and the Davis Mountains area promote this trend. It is expected that the trend toward retirement and second home markets will continue to dominate development of the county.

Consultation with area realtors indicates that little development has taken place since 1980 in the commercial, industrial, or other significant areas. Business and industrial demand has not occurred, and real estate development in these areas has lagged.

7. Recreation and Tourism

Recreation and tourism is a major industry in the area. Private estimates indicate that hunting leases in the area may produce as much as one million dollars. Fort Davis National Historic Site, McDonald Observatory, and the Davis Mountains Scenic Loop draw increasing numbers of tourists each year. The county lies in the heart of Region 8, included in the 1985 Texas Outdoor Recreation Plan. The region contains six counties, three of which adjoin Jeff Davis County. The region contains 1.2 million acres of recreation land, of which 4,700 acres are fully developed. Prominent National and State parks include the Guadalupe

Mountains National Park, the Big Bend National Park, and the Davis Mountains State Park in Jeff Davis County. Other significant areas include:

Hueco Tanks State Historical Park
Fort Leaton State Historic Site
Black Gap State Wildlife Management Area
Rio Grande National Wild and Scenic River

The Region 8 inventory includes 150 parks, 1342 campsites, 393 miles of trails, 740 picnic tables, 70 tennis courts, 26 natural areas, and 230 surface acres of lakes. The natural beauty of the desert and mountainous areas draw numerous visitors. Large game mammals include elk, mule deer, white-tailed deer, javelina, and antelope. Game birds include several species of quail, dove, turkeys, and chuckar.

8. Ranching

Ranching is the dominant agricultural activity in the county and the most prominent economic sector. Ranching in Jeff Davis County is well established, often conducted on large holdings. Between 1978 and 1982, the U.S. Census of Agriculture noted no significant fluctuation in the number of beef cows in inventory in the county (Table III-9). The number of cows and calves sold during that period declined by approximately 15 percent to 18,788 in 1980. However, the value of beef cattle sold remained fairly stable, decreasing by 5 percent to $6,591,000 in 1980. The production of hogs, sheep, and poultry showed an increase during the period, but the contribution to the local economy is still relatively small. A significant improvement occurred in the production and sales of horses, increasing in sales from $23,000 to $65,000 during the four-year period. This would indicate the growing importance of the horse industry with production of pleasure horses, working ranch horses, and race horses.

9. Farming

The U.S. Census of Agriculture (1978 and 1982) reported a total of 78 farms in the county, up from 58 during the period (Table III-10). The predominant number

Table III-9

Ranching Industry, 1978-1982
Jeff Davis County, Texas

	1978	1982
Beef cows inventory	21,327	21,416
Cattle and calves sold	21,543	18,788
Value of beef cattle sold	$6,905,000	$6,591,000
Hogs and pigs inventory	33	103
Hogs and pigs sold	-	178
Value of hogs and pigs sold	-	$17,000
Sheep and lamb inventory	-	-
Sheep and lamb sold	-	-
Horse and pony inventory	779	873
Horse and pony sold	86	70
Value of horse and pony sold	$23,000	$65,000
Poultry inventory (chickens)	124	62
Poultry sold	-	-
Value of poultry sold	-	-
Grains harvested		
Corn		
Sorghum		
Wheat		
Barley		
Oats		

Table III-10

Farms and Land in Farms, 1978-1982

	1978	1982
Farm numbers	68	78
Land in farms	1,570,075	1,621,940
Acreage size	23,089	20,794
Value of land and buildings (average per farm)	$1,702,044	$2,471,333
Value of farms (average per acre)	$74	$119
Acres harvested		
1-20	5	12
20-50	4	1
50-100	1	-
over 100	3	-

of acres harvested per farm in 1982 was under 20 acres. The farm economic sector has not been a significant segment of the county's economy. Table III-11 lists the number of farms as a function of sales over this period.

10. Mining

Most mining activity in the area is in the production of oil and natural gas. In 1980, only a small number of employees were reported in mining, and none were reported in 1985. This has resulted from a general and extensive decline in the oil and natural gas economy over a large area of the state and the southwest. The decline in the oil business began in the late 1970s and has continued until 1985 when oil and gas productions in the area ceased. It is not expected that the mining sector of the economy will return with any great effect, particularly with oil prices below $20 per barrel. It is doubtful that oil production in Jeff Davis County will be viable in the near future.

11. Forestry

Forestry is not a significant factor in the area economy. The industry was not considered of sufficient importance to be included in the original assessment.

I. Water Resources

1. Ground Water Resources

The Valentine MOA is located within the Rio Grande Basin. Groundwater is the major source of potable water and irrigation water in this area. The Alluvium and Bolson Deposits Aquifer underlies much of the upper part of the MOA and is the only source of groundwater. Total thickness of deposits in the area ranges up to more than 5,000 ft.; however, the deepest known occurrence of fresh water is about 1400 ft. below ground surface. Groundwater in the area supplies a large percentage of the water used for both irrigation and municipal purposes. Yields of high-capacity wells generally range from 1,000 to 1,500 gallons per minute (gpm), although large capacity wells in the aquifer in the northern areas of

Table III-11

Market Value of Agriculture Products Sold
Jeff Davis County, Texas

	Number of Farms 1978	1980
Less than $1,000	7	8
$1,000-$2,499	8	5
$2,500-$4,999	3	9
$5,000-$9,999	5	8
$10,000-$19,999	5	9
$20,000-$39,999	9	13
$40,000-$99,000	16	12
$100,000-$249,999	6	7
$250,000 or more	9	7

Hudspeth and Presidio Counties may yield up to 2500 gpm. Groundwater in the Alluvium and Bolson deposits contain between 1,000 and 4,000 milligrams per liter (mg/1) of dissolved solids and range from fresh to moderately saline quality.

2. Surface Water Resources

The main source of surface water in the area is the Rio Grande River. The only other potential sources include small ponds used mainly for recreation or livestock, and intermittent creeks and streams that are recharged during infrequent periods of precipitation. The main source of precipitation in the area is rainfall which can differ several inches (10 to 16 inches received annually in the area) due to changes in the elevation. On the stretch of the Rio Grande downstream from El Paso to Presidio, the quality of the water is poor. The Rio Grande River has depressed oxygen levels, elevated nutrients, and elevated fecal coliform levels as a result of inadequately treated municipal and industrial effluent discharged primarily from the Mexico side of the river.

J. Airspace

The airspace below the floor of the proposed airspace and adjacent to the Valentine MOA is used by other military and civilian aircraft. Several flight patterns cross the Valentine MOA. Route AR-650 is scheduled by the 67th TRW at Bergstrom AFB, Texas, and when in use is active from FL 180 - FL 290. Routes IR-165, 102, 122, 130, 141, and Jet Route J-42 also are moderately active.

1. Civilian Uses

Civilian airfields near the Valentine MOA are located at Marfa and Presidio (Presidio County) and at Van Horn (Culberson County). These airfields are used by general aviation with no scheduled airlines operating in the vicinity. Both Victor and Jet airways are depicted on the map. V-81 and J-42 are used for routing into Mexico.

2. Military Uses

Three of the six routes used by military aircraft in the area are used for low level navigational training. The IR-144 and 165 were established by the 67th TRW from Bergstrom AFB, Texas. The other IR routes (IR-102, 122, 130 and 141) were established by the Air Force Flight Test Center at Edwards AFB, California for test flights of the ALCM and are seldom used. Aircraft altitudes along the route vary, but generally are from near surface (100 ft.) to 10,000 ft. MSL in the vicinity of the Valentine MOA and from near surface (100 ft.) to 17,000 ft. MSL along the rest of the route. Airspeeds are limited to a minimum of 270 knots True Air Speed (TAS) and a maximum of 540 knots TAS.

IV. ENVIRONMENTAL CONSEQUENCES

A. Climate

The conduct of a maximum of 300 training sorties per month at the Valentine MOA should have no measurable impact on the area's climate. The most likely impact, if any, to the climate would be from pollutants emitted throughout the atmosphere. The number of sorties, amounts of pollutants generated and dispersion characteristics are such that meteorological conditions would not be affected.

B. Geology

Operation of the Valentine MOA is not expected to have any impact on the geology or physiography of the area. There is a remote possibility, however, that sonic booms could cause rockfall, avalanches, and earth slides. In such instances sonic booms may be the ultimate triggering factor to a natural process which would have ultimately produced the same effect. Specific studies conducted for evaluating this phenomenon were inconclusive (Slutsky 1975).

C. Soils

The training mission proposed at the Valentine MOA would have no foreseeable impact on the local soils. Flights would not be near enough to the ground to generate blowing dust or accelerate erosion processes.

D. Air Quality

The counties encompassed by the Valentine MOA are within the El Paso-Las Cruces-Alamogordo Air Quality Control Region (AQCR) (Federal Air Quality Control 1972). USEPA considers the area's, air quality to meet or exceed the standards or cannot be classified in respect to attainment of the carbon monoxide, ozone, and nitrogen dioxide standards. The Valentine MOA is not located in an Air Quality Maintenance Area.

Military aircraft presently conducting subsonic flight training operations within the Valentine MOA emit air pollution contaminants of particulates, hydrocarbons, carbon monoxide, sulfur oxides, and nitrogen oxides. Table IV-1 provides an estimate of the annual pollutant emissions from subsonic military operations in the Valentine MOA. The quantity of each pollutant was derived by using data for F-15 aircraft pollutant emission rates (USAF 1978) and the projected annual hours of flying activity in the MOA.

While the conduct of supersonic flight does not increase the sortie rate or flight time over subsonic action, the rate of pollutant generation and annual amount of pollutants does increase due to the slightly higher engine power setting required to achieve and maintain supersonic flight. Supersonic flight results only in increasing concentrations of carbon monoxide, hydrocarbons, and sulfur oxides emissions by 1.25, 0.1, and 1.0 metric tons per year, respectively. The quantity of particulates would virtually remain the same, while nitrogen oxides would decrease by about 7.2 metric tons per year due to the operational efficiency of the afterburners used during supersonic flight.

These pollutants would be emitted over the MOA area at an elevation ranging from 8,000 ft. (over mountain peaks) to 51,000 ft. MSL. EPA shows the area's mean annual morning and afternoon mixing heights to be about 1,600 ft. and 8,500 ft. AGL, respectively (Holzworth 1972). The mean annual wind speed averaged through the morning and afternoon mixing heights are 11 and 13 miles per hour, respectively.

As indicated above, a very small amount of the pollutants would be emitted below the mixing height. That which is emitted within the mixing height should not create a significant negative impact because the area has good dispersion characteristics. Some dispersion would also occur as a result of the turbulent wake behind the aircraft. Those pollutants emitted above the mixing height remain aloft until the mixing height exceeds the altitude in which the pollutants were emitted or the pollutants are washed from the upper atmosphere by rain. By this time, the pollutants have traveled a great distance (sometimes hundreds of miles) and would be greatly diluted before being returned to ground level.

TABLE IV-1

Estimated Annual Pollutant Emissions in Valentine MOA

POLLUTANT	F-15 EMISSION RATE (METRIC TONS/HR)	Estimated HOURS/YEAR	METRIC TONS/YR.
Carbon monoxide	8.4×10^{-3}	2,800	23.52
Hydrocarbon	9.4×10^{-4}	2,800	2.63
Nitrogen Oxides	2.5×10^{-1}	2,800	700.00
Particulates	3.2×10^{-3}	2,800	8.96
Sulfur Oxides	9.4×10^{-3}	2,800	26.32

Source: U.S. Air Force 1978a.

Considering the relatively small change in pollutant emissions, dispersion characteristics and altitudes involved, operation of the Valentine MOA as previously defined should not result in a significant impact to local air quality.

It is possible that as a result of an emergency, fuel could be jettisoned into the atmosphere to reduce the gross weight of the distressed aircraft. Previous 49th TFW operational experience indicate that such occasions are extremely rare (less than five per year). Any fuel jettisoned would be above the 15,000 ft. MSL floor of the MOA and would be highly aspirated due to the fuel particle velocity and resistance of the atmosphere; thus, it would evaporate long before it reached ground level. No increased potential for fuel dumping results from supersonic training as compared to subsonic training.

E. Noise

1. General

Noise in the Valentine MOA will result from aircraft operations conducted at subsonic and supersonic speeds. Aircraft in the area will be subsonic during most of their flight, but will occasionally accelerate to supersonic speed.

2. Subsonic Noise Impact

The long term day-night average noise level (DNL) from subsonic flight operations in the Valentine MOA would be typical of a rural community. DNL is an equivalent sound level averaged over a twenty-four hour period with a ten decibel penalty added to any sound that occurs at night. As an example, if the expected daily average of 15 sorties were to pass directly over the same spot at 10,000 ft. above the ground, the DNL would be 31.6 decibels (dB). A DNL of 40 to 47 dB is the typical range of noise levels for a rural community (National Research Council 1977). DNL's below 55 dB are considered by the EPA (USEPA 1974) to have no significant effect on public health and welfare. The U.S. Department of

Housing and Urban Development considers DNL's below 65 dB acceptable for residents without noise attenuation.

3. Supersonic Noise Impacts

a. Summary

Before discussing sonic boom impacts, a summary of the sonic boom phenomenon and characteristics specific to the Valentine MOA is provided. The reader who desires a more indepth review of this is referred to Appendix D of the original Valentine MOA Draft Environmental Impact Statement (USAF 1979), which contains more detail of the following phenomenon.

When aircraft exceed the speed of sound (Mach 1) a sonic boom is produced. The boom is an instantaneous sound similar to a thunder clap. Noise levels can vary considerably, depending on the aircraft size, speed, and distance to the observer. The maximum overpressure of a sonic boom is produced directly beneath the aircraft in flight and decreases with increased lateral distance from the flight track and with increased altitude of the aircraft above ground level.

An important consideration in the assessment of the effects of sonic booms is that not all booms created are heard at ground level. Sonic shock waves or rays are created when an object is traveling at a rate greater than the speed of sound. The speed of sound at any altitude is a function of the temperature; a decrease in temperature results in a decrease of sound speed, and vice versa. Under standard atmospheric conditions, the air temperature decreases with increases in altitude (for example, when the sea level temperature is 59°F, the temperature at an altitude of 30,000 ft. is about -49°F). Thus, there is a corresponding decrease in speed of sound and sonic shock waves will not penetrate below altitudes at which the local speed of sound is greater than the speed of the aircraft. Therefore, the shock waves are refracted back to higher altitudes if the plane moves subsonicly with respect to the speed of sound at ground level, although its speed at altitude is greater than the corresponding speed of sound. For example, at 30,000 ft. altitude, an aircraft may have to exceed a speed of

Mach 1.13 before the boom would be heard on the ground. The heights and Mach number produced during F-15 combat maneuvering operations are such that less than one boom out of every three produced is likely to be heard at ground level. The other two of the three booms are refracted upward and are not heard at the ground. This same phenomenon, "cutoff", also acts to limit the width of sonic booms which reach ground level.

Elaborate procedures exist for calculating the pressure-time signature of sonic booms based on the specific shape and aerodynamics of the flight vehicle. An empirical procedure (Carlson 1978) has been developed for situations where peak overpressure is the feature of interest. The method allows determination of on-track and off-track overpressures for aircraft in level flight or in climbing and descending flight paths. The method uses basic aircraft operating conditions such as Mach number, altitude, weight and flight path angle. Comparison of sonic boom overpressures and duration as found from a wide range of measurements with those predicted by Carlson's (1978) procedure show the procedure is very accurate when atmospheric conditions are favorable for sound propagation. In nonstandard atmospheres (where there are winds and temperature deviations from the standard lapse rate which tend to distort the shock wave) the results are generally an overestimate and are thus considered to be the upper bound of the overpressure possible for the modeled conditions.

b. WSMR ACMI Model

An Air Combat Maneuvering Instrumentation (ACMI) system is not available in the Valentine or Reserve MOAs; however, one is available at the WSMR which is used for flight training in F-15s from Holloman AFB. Operations conducted at the WSMR are representative of those proposed for the MOAs. Therefore, using the ACMI data at WSMR and Carlson's procedure it is possible to model potential noise impacts in the MOAs. The only significant adjustment required before applying the WSMR data is to make a pressure altitude correction (Galloway 1980).

An investigation of sonic booms produced in the WSMR MOA airspace located over the north portion of WSMR and the North Extension Area was performed from July 1988 through January 1989, for the purpose of developing a sonic boom model.

The WSMR model determined by Wyle (1989) is represented by twin equations:

(1) $$CDNL = 25 + 10 \log_{10}N + 10 \log_{10}EXP\ (1/2[(X/11.1\ Mi)^2 + (Y/18.9\ Mi)^2])$$

and,

(2) $$n = 0.0012\ N\ EXP\ (-1/2[(X/13.0\ Mi)^2 + (Y/21.4\ Mi)^2])$$

where:

N = number of sorties per month
X = X-coordinate (noise contour) of a specific location
Y = Y-coordinate (noise contour) of a specific location
CDNL = C-weighted day-night noise level at the specific location
n = number of predicted booms per day at the specific location

CDNL and noise contour plots can be generated from the above equations and plotted to illustrate anticipated noise levels and sonic boom frequency at ground level. The CDNL and n contours are a function of the number of operation sorties with more sorties increasing the CDNL value and the predicted number of sonic booms per day at any given locations.

c. Valentine MOA Noise Prediction

The WSMR noise model described above was applied to the Valentine MOA to predict the effects of flying the maximum anticipated 300 sorties per month. For modeling purposes only, it was assumed that 150 sorties per month would be flown to the north and to the south of the primary population center (i.e., City of Valentine) within the Valentine MOA. Actual noise levels will potentially be less due to the random alignment of sorties being flown throughout the MOA.

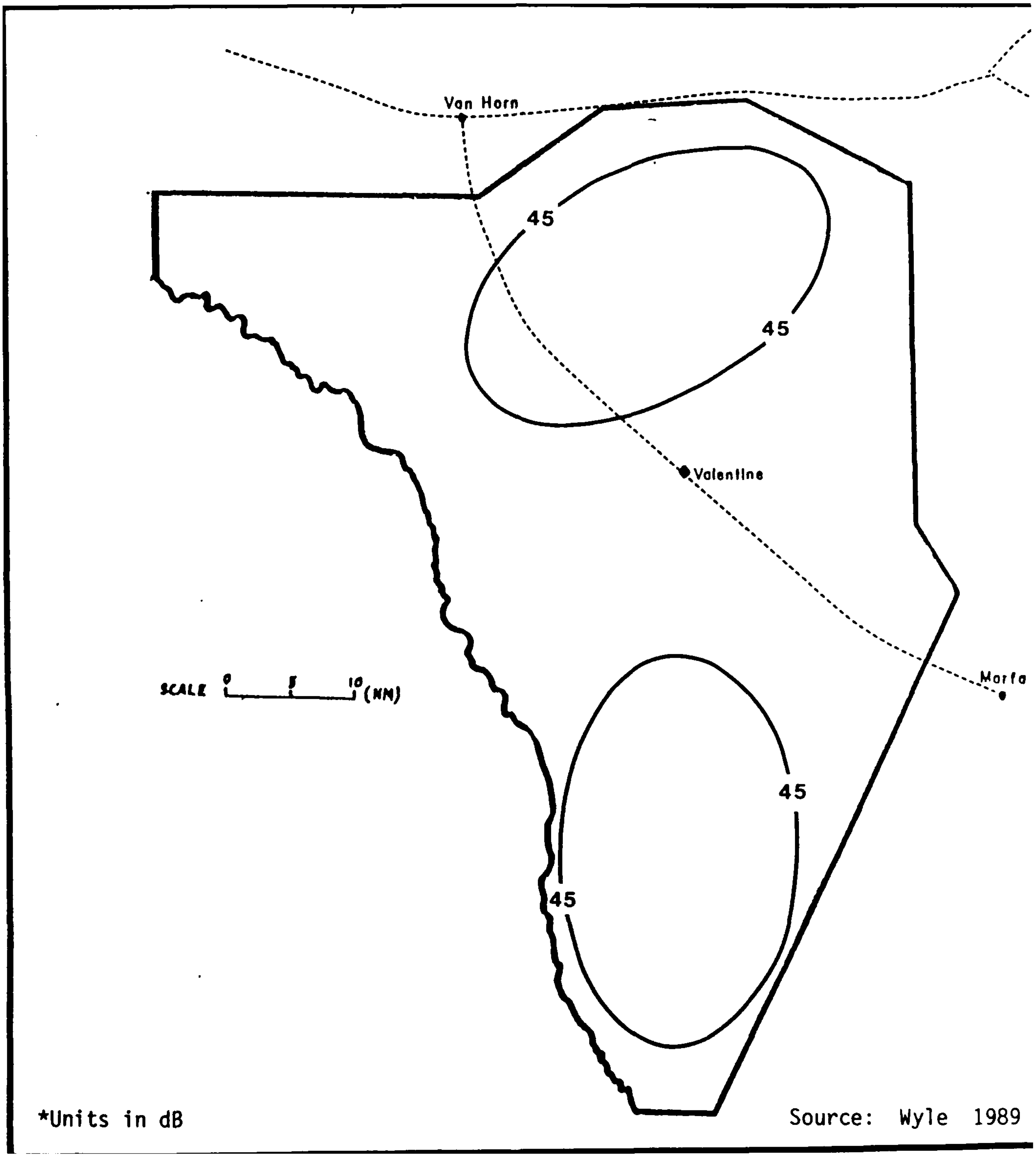
Figures IV-1 and IV-2 present the predicted CDNL noise levels and anticipated sonic booms per day (n) within the Valentine MOA. Anticipated noise levels above 50 dB did not exist. The 45 dB contour represents the area outside of which the percent population that would be highly annoyed is less than 1.4 (National Research Council 1977). Figure IV-2 indicated that at virtually any location outside the Valentine MOA less than one sonic boom would be heard every 10 days (0.1/day).

The Environmental Protection Agency (EPA) Office of Noise Abatement and Control (USEPA 1974) indicates little or no public annoyance is expected to result from one sonic boom during the daytime below 0.75 pounds per square foot. The same low probability of annoyance is expected to occur within CDNL areas of less than 50 dB as illustrated in Figure IV-1. Maximum CDNL anywhere within the Valentine MOA was modeled to be less than 50 dB. Considering these data, the National Reseaich Council findings, and the EPA noise annoyance criteria cited above, sonic boom generated noise from operating supersonic training within the Valentine MOA is not considered to have a significant impact on the local environment.

F. Biological Resources

1. Vegetation

Construction of runways, prop zones, etc. would not be required for the proposed operations and thus no direct losses to vegetation would be expected. No physical contact with the MOA terrain would be made unless for unexpected recovery of lost or downed equipment. Fires may occur in the event an aircraft crashes. Due to the sensitive ecosystem of the MOA, vegetation communities could require several years to recover from associated fires. The magnitude of the effect would depend upon several variables including fire fighting response time and efficiency, season in which the fire occurs, habitat type affected, and subsequent precipitation. There currently are no data available on the adequacy of fire fighting capability or response time, due to the extreme variety of aircraft crashes within these areas.


Van Horn
45
45
Valentine
SCALE 0 5 10 (NM)
Marfa
45
45
*Units in dB
Source: Wyle 1989

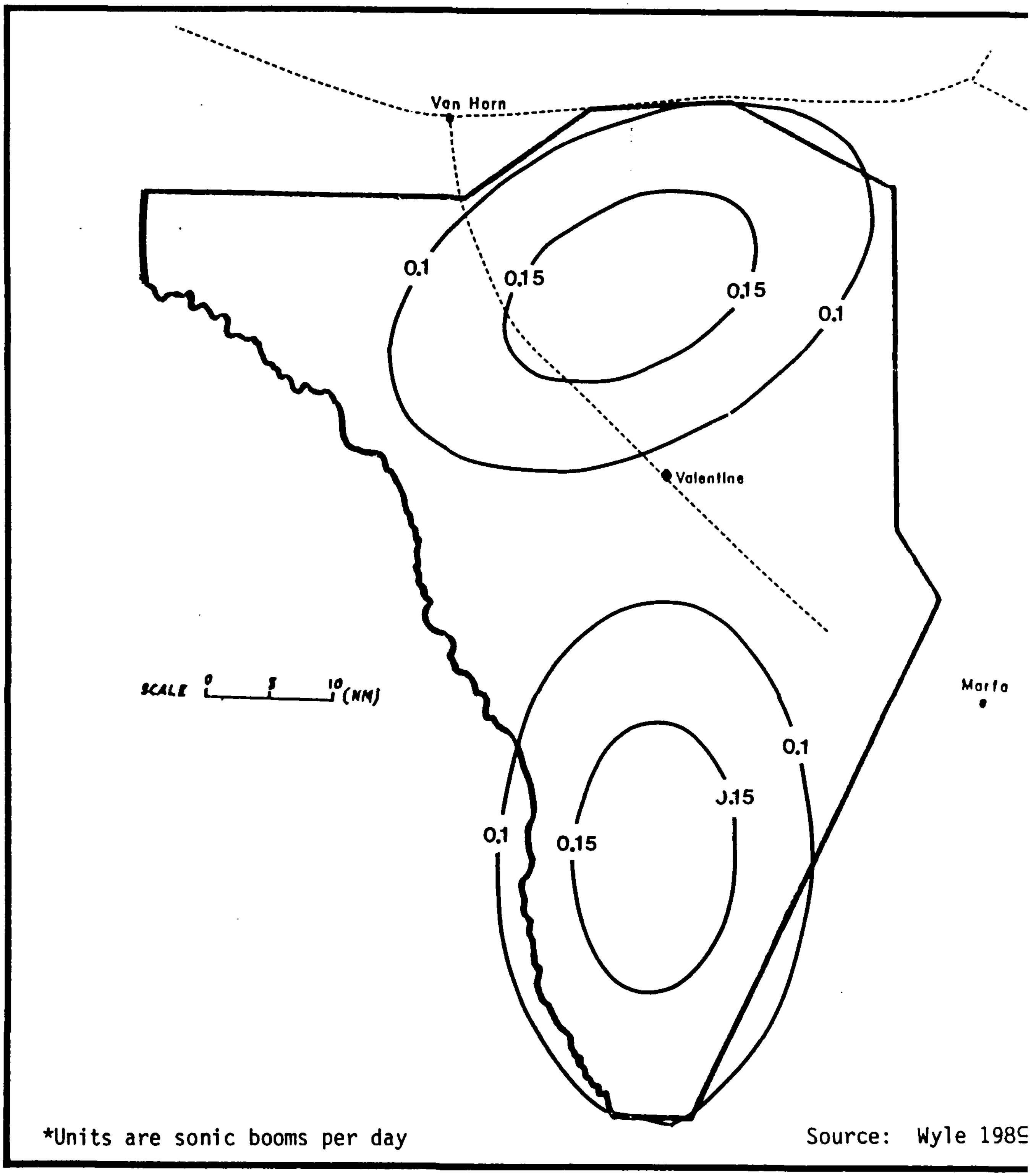


FIGURE IV-2 Predicted Sonic Boom Activity at Valentine MOA Based on WSMR Model.

2. Reptiles and Amphibians

Compared to studies of sonic boom effects on mammals, birds and fish, little has been accomplished with reptiles and amphibians. The impact of proposed operations within the Valentine MOA on these fauna is not well establisned. However, it is expected that the impact should not be significantly different from the other fauna and be of minimal extent.

3. Fish

The only continuously flowing body of water in the area is the Rio Grande which forms the western border of the MOA. Fishing waters are limited to small ponds that have been stocked with black bass, channel catfish, and sunfish. Rainbow trout have been stocked in spring-fed ponds and stock ponds at higher elevations where the water remains cold enough to support the trout (U.S. Department of Agriculture 1977).

Many studies have been conducted to determine the sensitivity of fish to sounds. Though these have indicated some sensitivity of fish to low frequency sounds, little information is available on the normal responses of fish to either naturally occurring or man-made sounds. There is a great reduction in sonic boom amplitude due to the acoustical mismatch between air and water, thus waterborne noise levels would be less than that in the atmosphere (Fletcher and Busnell 1978).

In one sonic boom study, a single fish did show a brief slowing of heart rate immediately after the arrival of the boom (Fletcher and Busnell 1978). A study conducted at the Ames Research Center (Runyon and Kane 1973) involved simulated boom overpressures of 550 pounds per square foot (psf) which impinged upon a clear tank containing guppies. The fish usually reacted to the passage of the shock wave by a flinching motion occasionally followed by a rapid movement, generally downward. There was a greater reaction by fish near the surface than by those near the bottom. The fish that did react did not appear to be alarmed and settled down immediately. "The exposed fish were kept isolated for

observation for two months after the test and no adverse effects to the boom were noted" (Runyon and Kane 1973).

In a second investigation conducted at AMES Research Center trout and salmon eggs in their most critical phase of development were exposed to sonic booms generated by military aircraft where overpressures ranged from less than 1 to 4 psf. In each experiment a control group of eggs spawned at the same time as the experimental group which was reared in a separate location and not exposed to sonic booms. The number of egg and fish fry mortalities for each group was compared. Results indicated sonic booms caused no increase in mortality (Runyon and Kane 1973).

4. Birds

During a 1966 Edwards AFB study, poultry exposed to sonic booms observed showed more response to the noise and overpressure than did the large animals (cattle, horses, etc.), especially in the early stages of the test. Occasional flying, running, crowding, and cowering were noted (Fletcher and Busnell 1978). Hinshaw et al. (1970) reported that hens exposed to four booms per day tended to run to shelter after the first boom, but later booms had less effect. Poultry showed mild reactions to the booms in 50 to 90 percent of the cases. In eight percent of the cases, the chickens reacted with crowding, cowering, or pandemonium but with no measurable effect on egg production.

Wild avian species will occasionally run, fly, or crowd when exposed to sonic booms. In a field and laboratory study (Teer and Truett 1973) mourning doves, mockingbirds, cardinals, lark sparrows, and quail were exposed to sonic booms or simulated boom overpressures to discover if booms adversely affected reproduction. Some differences in various phases of reproduction success were found between the control and test groups; however, none of the comparisons indicated the differences were caused by other than natural environmental factors. The laboratory test involved 7,425 incubated bird eggs which were observed to hatching. Chicks hatched from these eggs were observed to twelve weeks of age. Pressures of 2, 4, and 5.5 psf were delivered to the incubated

eggs at three frequencies each day for 18 days. "Results of these tests showed that the pressures had no effects on hatching success, growth rates, or mortality" (Teer and Truett 1973).

A study conducted by Ellis (Ellis 1981) under cooperative agreement between the U.S. Fish and Wildlife Service (USFWS) and the USAF on the peregrine falcon involved gathering data at twenty-four breeding sites of ten raptorial birds in an effort to record responses to low level jets and sonic booms. The study concluded that, "while the birds were often noticeably alarmed by the subject stimuli, the negative responses were brief and never productivity limiting. In general, the birds were incredibly tolerant of stimulus loads which would likely be unacceptable to humans." The USFWS review of the Ellis study concluded that jet aircraft flights under 5,000 ft. AGL and mid to high altitude (higher than 5,000 ft. AGL) supersonic flight activity is not likely to jeopardize the continued existence of the peregrine falcon in the Valentine MOA Draft EIS (USAF 1979) (see Chapter 10 for FWS January 18, 1982 Letter).

5. Mammals

Domestic animals such as cattle, horses, sheep, and poultry show very little behavior effect from exposure to sonic booms (Cottereau 1972; Fletcher and Busnell 1978; Hinshaw et al. 1970; Nixon et al. 1968; International Civil Aviation Organization 1970). Effects on farm animals (horses, beef cattle, turkeys, broilers, sheep, dairy cattle, and pheasants) in 1966 at Edwards AFB show the behavioral reactions were considered minimal except for avian species. "Occasional jumping, galloping, bellowing, and random movement were among the effects noted. The responses of the large farm animal in these tests were judged to be in the range of normal activity in comparison with animals observed under controlled conditions. Pigs, both in the open and in buildings, showed a transient tendency to be quiet". Other scientists' review (International Civil Aviation Organization 1970) of the Edwards AFB study indicate the range of sonic boom overpressures was 1.7 to 3 psf. "Large farm animals reacted to the boom in some three to ten percent of the cases (e.g. occasional galloping of horses, bellowing of dairy cattle, increased activity of beef cattle); spontaneous

behavior of this sort was, however, asserted to be equally prevalent in the absence of booms according to comparison observations in boom-free farm animals in a different state. There was, on the other hand, no measurable effect of these reactions on milk production, and food consumptions... It was observed that more severe reactions resulted from low level subsonic flights, motor cycles, paper blown by the wind and other startling effects" (International Civil Aviation Organization 1970). Nixon et al. (1968) and Fletcher and Busnell (1978) confirm the above observations for horses and cattle and cattle and sheep, respectively. Hinshaw et al. (1970) also states horses, cattle, and sheep show brief periods of startle, but soon return to normal activity.

Fletcher and Busnell (1978) states cattle are generally described as briefly stopping their current activity or moving several steps and orientating toward the direction of the sound. Horses have been reported to show a more violent reaction than other grazing species. A few have been reported as showing muscular tremors, galloping, and jumping. There is a possibility that horses confined in buildings may show an exaggerated response as a result of being alarmed. Sheep have been described as temporarily stopping feeding, grazing, running or ruminating in response to sonic booms. There appears to be no report of panic, injury, or impaired reproduction to any domestic animals evaluated (Fletcher and Busnell 1978).

Observations made by personnel (at the Luke Air Force Range, Arizona), regarding responses of bighorn sheep to sonic booms indicate minimal impacts of disturbance to the sheep (USFWS 1979). These observations are listed in Appendix D of the Valentine MOA Draft Environmental Impact Statement (USAF 1979). Desert big horn sheep on the Nellis AFB Range, Nevada, which have been exposed to sonic booms since 1955, show no significant change in the sheep population's age structure, longevity, or reproduction success. The population has been maintained around 1500 sheep since 1947 by harvesting (trophy hunts) and removing sheep to establish herds in other parts of Nevada. The Nellis AFB Range supports Nevada's largest population of sheep which accounts for about 40 percent of the state's total population (McQuivey 1978). Thus, it is not expected that the

bighorn sheep in the Valentine MOA will be significantly impacted by supersonic operations.

6. Threatened and Endangered Species

Studies and experiments using a variety of mammals, birds, and fish have been performed including that by Ellis (1981) involving the endangered peregrine falcon. Results of these studies indicate no serious impact to test species from sonic booms. It is anticipated that the other threatened or endangered species (Tables III-8 and III-9) such as the bald eagle and comanche springs pupfish would likewise not be impacted. Although there are four species of cactus, one species of oak and three other assorted species of plants listed as threatened or endangered on or around the Valentine MOA (R. Short, personal communication 1988) no aspect of the proposed training should impact these flora.

7. Summary

Cottereau (1972) reports in all the studies he reviewed concerning sonic booms, whether real or simulated, that the authors came to the same general conclusions: sonic booms and subsonic flight noise has very little effect on animal behavior. "Chronic direct effects on wild animals have not been investigated but no significant effects of this kind are presently foreseen".

The Federal Aviation Administration (FAA) (1973) arrived at the following conclusions:

- Animal damage claims are only a very small fraction of the total damage claims that have been submitted to the Air Force.
- The behavioral reactions of farm animals to sonic booms are, for the most part, minimal.
- All experimental evidence to date indicates that the exposure of chicken eggs to sonic booms does not affect their hatchability.
- Sonic booms do not appear to pose a threat to fish or fish eggs.

- Knowledge concerning the effects of sonic booms on wildlife is limited, but it appears that sonic booms do not pose a significant threat.

In summary, the available literature and special studies reviewed support the facts that domestic animals and wildlife can and do flourish in the presence of military aircraft operations, both subsonic and supersonic. Fletcher and Busnell (1978) recognize this by pointing out that if aircraft noise was detrimental to wild animals, areas around large airports would be devoid of wildlife. This would also be true for military operating areas. Both the Nellis and Luke Air Force Ranges are approved for low level and supersonic flight and are colocated with wildlife refuges. Animals and wildlife on these ranges have been exposed to sonic booms for over 25 years with no apparent significant effect. It is thus concluded that while some individual animals may show an adverse response, the species as a whole should not be significantly impacted if the proposed supersonic operations are conducted over the Valentine MOA.

G. Cultural/Historical Resources

1. Synthesis of Available Data Concerning Impact of Sonic Booms

This synthesis of the available technological data related to sonic booms will summarize (a) damage effects to conventional structures, (b) damage effects to unconventional and natural structures, and (c) seismic responses.

a. Sonic Boom Damage to Conventional Structures

The response of modern conventional structures to sonic boom pressure waves is a complex phenomenon because of the many interacting variables which determine how a given structure will react. The many technical reports and papers which have been published over the past 25 years have attempted to predict damage levels through a combination of experimental programs and theoretical studies. Due to the complexity of the matter, however, the most consistent method of determining actual effects is through experimental programs. Consequently, three instrumental tests conducted in the 1960s provide the bulk of the data related

to structural damage. The studies include flight tests performed in Oklahoma City at White Sands Missile Range, New Mexico (Blume et al. 1965), and at Edwards Air Force Base, California (Blume et al. 1967).

The Oklahoma City study was the first extensive flight test investigation of structural response. A series of flights was conducted over a six month period in which overpressures of 1 to 1.5 psf and instrumental responses of residential structures were recorded. The White Sands program was designed to study damage index levels associated with various types of structural materials such as plaster, glass, and masonry. The test site which included 21 structures, ranging from newly constructed to uninhabited, old ranch houses, was subjected to 1,494 booms. The intensity of the booms varied from 1.6 to 23.4 psf. The Edwards Air Force Base investigations involved 102 flights and two instrumented structures. Overpressures of .97 to 5.5 psf were recorded. These three studies have contributed to the following conclusions:

(1) For nominal overpressures of up to 30 psf, damage will be minor in the form of plaster cracks, broken window panes, and masonry and tile cracks. Damage may be predicted only within several orders of magnitude (e.g., 10^{-5} to 10^{-2} broken windows per window boom exposure for 6 psf booms); however, it is known that damage rates will increase by 2 to 3 orders of magnitude for each doubling of the sonic boom overpressures (Hershey and Higgins 1973; Wiggins 1969).

(2) There is no evidence of damage or cumulative damage where the predicted overpressure is approximately 3.0 psf or less (Wiggins 1967; Runyan et al. 1973). Limited data are available which suggest that cumulative damage may result from recurring exposure to overpressures greater than 10 to 15 psf (Blume 1965).

(3) Building structures which have been maintained should not be damaged at boom overpressures less than 11 psf (Clarkson and Mayes 1972).

b. Sonic Boom Damage to Unconventional and Natural Structures

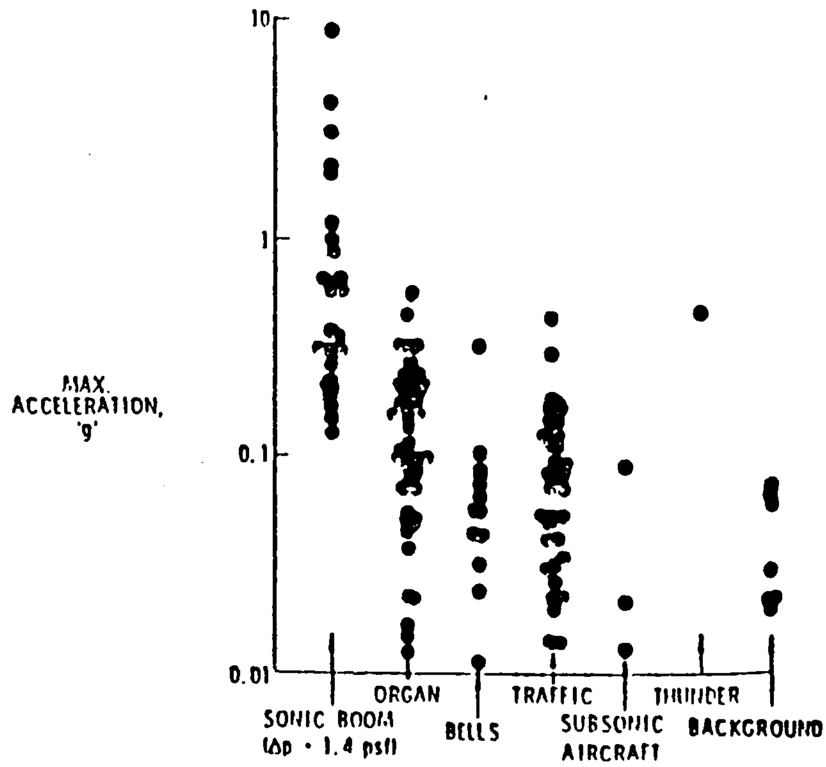
The potential damage of sonic booms to unconventional structures such as historic buildings, archeological structures (standing walls or pueblos, modified caves),

or natural structures (rockshelters and rock art sites) is not as well documented as for conventional structures. The number of studies directly related to such irreplaceable sites is extremely limited. The unique nature of some of these resources (petroglyphs and pictographs) and their often fragile state in comparison to modern structures contribute to the concern regarding the applicability of the larger body of data related to conventional structures. Consequently, recent research efforts have been directed toward examining the impact of sonic booms on specific historic or archeological resources.

The initial studies related to historic structures were in response to the proposed Concord flights in Europe and North America. The Royal Aircraft Establishment, Farnborough, England, initiated a series of studies (Warren 1972) to determine the effect of sonic booms on cathedrals and public and domestic buildings which are centuries old. In order to assess the magnitude of the effect of the sonic booms, the effect of everyday sources of vibration (organ, bells, traffic, atmospheric turbulence, thunder) were monitored also. As can be seen in Figures IV-3 and IV-4, (from Clarkson and Mayes) the response of structural elements to the sonic booms was somewhat greater than the response to the normal environment. The response to the sonic booms, however, was not regarded as sufficient to cause damage to the historic structures (Warren 1972).

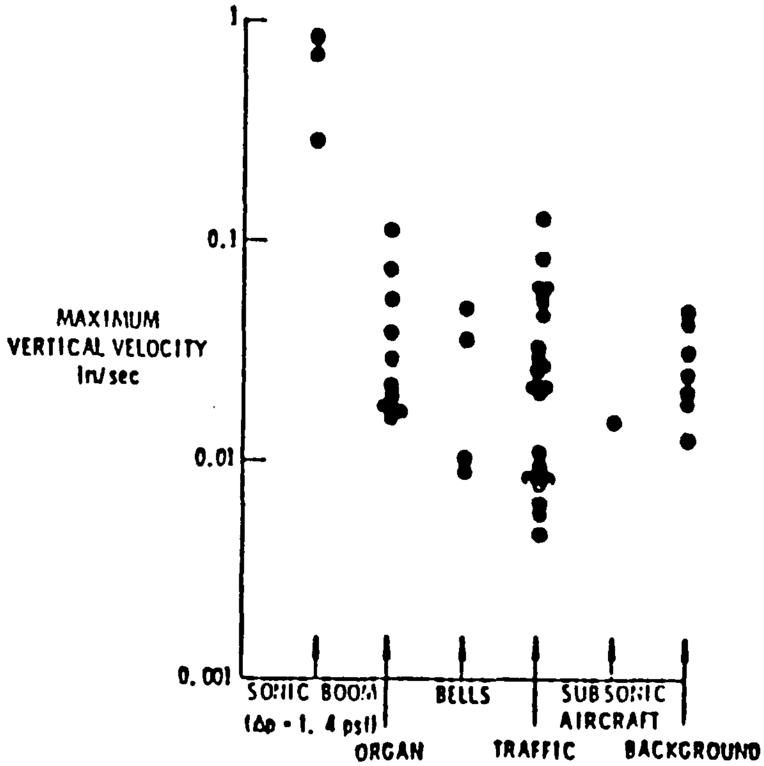
An investigation of the response of an adobe structure to sonic boom activity has also been conducted. An adobe house on the Tohono O'Odham Reservation was instrumented and evaluated while supersonic flight training was conducted overhead. The conclusion of the study was that the adobe structure reacted similarly to a conventional structures (USAF 1979).

More recently, seismo-acoustic recordings of sonic booms were recorded at two sites within the Valentine MOA. A rockshelter site and a boulder field site, similar to that of a petroglyph site within the Valentine MOA, were instrumented so that overpressures and peak velocities could be measured. Of 10 overflights, only two sonic booms were actually detected on the ground. The generated peak overpressures were 0.103 psf and 0.123 psf for the rockshelter and boulder field, respectively. Battis (1981) noted that these values are significantly less than



Source: Clarkson and Mayes 1972: 752

FIGURE IV-3 Response of Cathedral Windows to Transient Pressure



Source: Clarkson and Mayes 1972: 752

FIGURE IV-4 Response of Cathedral Vaulting to Transient Pressure

expected for an F-15 flying at Mach 1.1 between 15,000 and 20,000 ft. AGL, but offered no explanation for the apparent differences. Battis further notes that the expected motions are, at worst, eight percent of the limits set by strict blasting codes (Siskind et al. 1980a) and comparable to velocities which might be produced by local, low magnitude earthquakes.

Unfortunately, these studies do not provide levels of overpressures at which historic structures or archeological resources will be negatively affected by sonic boom activity. They merely support the general impression that such structures may be less sensitive than popularly thought; no "safe" limits have been defined. The only available guidelines are derived from tests associated with blast-related vibration (Siskind et al. 1980b). According to the Bureau of Mines studies, the current consensus concerning the level at which architectural damage may occur is 50.8 mm (2.0 in)/second peak particle velocity (Siskind et al. 1980a). A conservative, safe level of ground motion for dwellings is in the range of 2.0 to 3.8 mm/second (Siskind et al. 1980a). Sedovic (1984) suggests that a safe level for historic structures is between 5.08 mm (0.2 in) and 12.7 mm (0.5 in)/second peak particle velocity (Figure IV-5). These limits are based upon test blast results published by the Bureau of Mines (1980). Conversion of Wiggins' (1980) peak displacement data to peak particle velocities (Siskind et al. 1980b) indicates that the sonic boom induced velocities reported by Blume et al. (1965 and 1967) were within the safe range as defined by Sedovic (1984). The peak particle velocities noted by Battis (1981) during the limited Valentine MOA study and the Railroad Valley, Nevada study are all well within the safe range, also. Assuming a 5.19 psf overpressure and using the maximum admittance value found in the Railroad Valley study, Battis notes that the projected velocity will be 2.1 mm (0.083 in)/second which is well within the arbitrarily defined safe range.

Views concerning a safe level of ground motion associated with historic structures differ, however. Ashley (1976), examining blast effects in urban areas, proposed peak particle velocities of 7.5 mm (0.3 in) and 12 mm (0.47 in)/sec for ancient and historic monuments and housing in poor repair, respectively. Technical data to derive or support these values are not

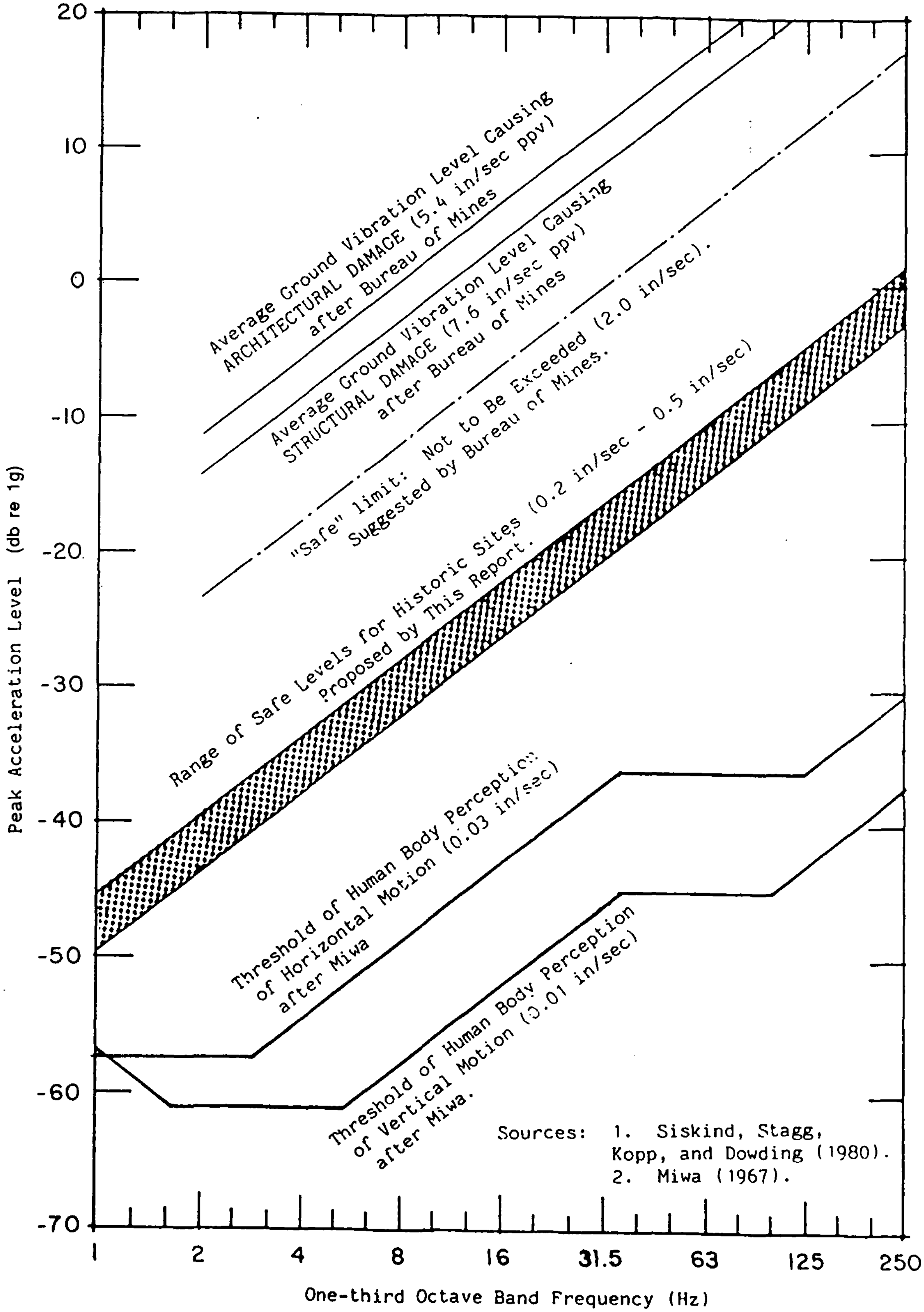


FIGURE IV-5 Comparison of Standards for Building Damage and Human Perception

presented. King et al. (1985) note that the generally accepted view in Germany, Great Britain, and Sweden is that historic structures and archeological sites should not be subjected to even minor, artificially induced ground motions. Government set levels of maximum ground motion for historic structures in these three countries are therefore 2 mm/sec, 2.5 mm/sec, and 2 mm/sec, respectively. King et al. (1985) in their vibration hazard investigations of Canyon Culture National Historical Park, concur with this perspective and recommend a 2.0 mm/sec particle velocity to be the upper limit for induced motions in structures.

The media which is subjected to vibration is also a determining factor of the potential damage level. Langefors and Kihlstrom (1963) and Esteves (1978) present thresholds for a variety of soil types, construction, and blast frequencies (Tables IV-2 and IV-3). The relationship of the propagation velocity (c) to particle velocity (V) and ground strain (e) ($e=V/c$) indicates that low velocity materials will have higher ground strains and potential for failure for a given particle velocity. Consequently, a rock formation will exhibit a higher threshold for damage than an alluvial soil; unfortunately, neither study presents experimental data to support its proposed thresholds.

c. Seismic Effects of Sonic Booms

Goforth and McDonald (1968) have conducted the most extensive experimental and theoretical investigation of seismic effects of sonic booms. Earth particle velocities recorded at three seismological observatories in California, Arizona, and Utah were correlated with overpressure, flight parameters, and meteorological data in order to evaluate the seismic impact of the sonic booms. Their study resulted in the following conclusions:

(1) Ground particle velocity produced by a sonic boom is linearly related to the maximum overpressure of the boom for overpressures less than 5 psf. Experimental data suggests that each pound per square foot of overpressure produces a peak particle velocity of 0.1 mm/sec on low density rock and 0.075 mm/sec on high density rock.

(2) Peak particle velocities on the exterior of the boom footprint are attenuated by a factor of 6 relative to the center of the footprint.

TABLE IV - 2 Damage Levels from Blasting
(Langefors and Kihlstrom 1963)

DAMAGE EFFECTS	PEAK PARTICLE VELOCITY					
	SAND, GRAVEL, CLAY BELOW WATER LEVEL: c= 1,000 - 1,500 m/sec (1)		MORAINE, SLATE OR SOFT LIMESTONE: c = 2,000 - 3,000 m/sec		GRANITE HARD LIMESTONE OR DIABASE: c = 4,500 - 6,000 m/sec	
	mm/sec	in/sec	mm/sec	in/sec	mm/sec	in/sec
No noticeable crack formation	18	0.71	35	1.4	70	2.8
Fine cracks and falling plaster threshold	30	1.2	55	2.2	110	4.3
Crack formation	40	1.6	80	3.2	160	6.3
Severe cracks	60	2.4	115	4.5	230	9.1

(1) Propagation velocity in media is given by c.

TABLE IV-3 Limiting Safe Vibration Values of Pseudo
Vector Sum Peak Particle Velocities (Esteves 1978)

TYPE OF CONSTRUCTION	PEAK PARTICLE VELOCITY					
	INCOHERENT LOOSE SOILS, SOFT COHERENT SOILS, RUBBLE MIXTURES: $c < 1,000$ m/sec (1) $c < 3,300$ ft/sec (1)		VERY HARD TO MEDIUM CONSISTENCE COHERENT SOILS, UNIFORM OR WELL-GRADED SAND: $c = 1,000 - 2,000$ m/sec $c = 3,300 - 6,600$ ft/sec		COHERENT HARD SOILS AND ROCK: $c > 2,000$ m/sec $c > 6,600$ ft/sec	
	mm/sec	in/sec	mm/sec	in/sec	mm/sec	in/sec
Special care, historical monuments, hospitals, and very tall buildings	2.5	0.10	5	0.20	10	0.40
Current Construction	5	.20	10	.40	20	.80
Reinforced construction, e.g., earthquake resistant	15	.60	30	1.20	60	2.40

(1) Propagation velocity in media given by c.

(3) Peak particle velocities recorded at a depth of 44 ft. are attenuated by a factor of 75 relative to those at the surface.

(4) One recording station provided evidence in support of the existence of velocity-coupled Rayleigh waves (Baron et al. 1966; Espinosa et al. 1968). However, these waves did not produce the maximum particle velocities associated with the boom. The necessary conditions of lateral uniformity of the near surface geological units and velocity distribution for the amplification of such waves to a damaging level is considered unlikely.

(5) The largest peak particle velocity recorded in association with a sonic boom of 2.5 psf was a velocity of 0.34 mm/sec. This amounts to less than 1 percent of the seismic damage threshold for residences established by the U.S. Bureau of Mines (Goforth and McDonald 1968).

Results obtained in ground motion studies in Great Britain confirm the above conclusions. The British experiments yielded peak particle velocities up to 0.3 mm/sec -- a value on the same order as that of passing vehicles (automobiles and trucks).

An additional concern is the possibility of avalanches or earth slides being triggered by sonic booms. The only cited test series (Lillard et al. 1965) in which the triggering of avalanches was attempted by producing sonic booms with nominal peak pressures of up to 10.4 psf failed to disturb the snow fields. The U.S. Forest Service, however, rated the avalanche hazard as "low" during the test period. Nevertheless, undocumented evidence exists which suggests that sonic booms can and do trigger avalanches (Rathe 1986). Credible observations of earth slides or rock fall being associated with sonic boom events exist, also. In 1967, the National Park Service reported the fall of overhanging cliffs immediately after a sonic boom. Cliff dwellings in Canyon de Chelly National Monument, Arizona were damaged. Within Bryce Canyon National Park, Utah three sonic booms were followed by the fall of 10 to 15 tons of earth and rock (U.S. EPA 1971). Unfortunately, such observations do not permit a scientific evaluation of the causal role of the sonic booms. The sonic booms may have been the primary factor in the triggering of the avalanches or earth slides. They may have been a minor contributing factor to a natural process which was about to produce the same effects. They may also have had no influence whatsoever on the avalanches but were merely coincidental.

d. Potential Impact of Focal Booms

It has been demonstrated theoretically (Onyeonwu 1975) and experimentally (Vallee 1967, 1972; Wanner et al. 1972; Haglund and Zane 1974) that focused or superbooms are quite rare, especially in regard to focus factors several times greater than that of level flight booms. The effect of the focused booms is also more localized than that of a carpet boom. As Plotkin (1985) notes, for a given maneuver, focus occurs only once on a fixed ground footprint. The intersection of the focus boom with the ground is a line rather than an area. A superfocus is even more limited in its effect, for its intersection with the ground is at one instant at a single point. Because of the different nature of focus booms, the chance of intersection with the ground is less than that of the carpet boom. When a focal zone does intersect with the ground, it is a single event rather than the continuous nature of the carpet boom (Plotkin 1985).

The most recent data concerning the impact of focal booms associated with tactical fighter maneuvers is derived from the comparison of flight test data and focus boom prediction models (Plotkin 1985). The following conclusions were reached through this study:

1. Areas where carpet boom overpressures are exceeded are on the order of 0.5 square mile.

2. Focal zones with focus factors of two or more occur over areas of about 0.1 square mile.

3. The highest predicted focus factors a:e about three times that of a normal carpet boom.

Although Plotkin (1985) and others (Fengler and Bishop 1986) downplay the probability of focus booms occurring, the fact that they do occur during tactical maneuvers and that they may exhibit overpressures two to three times greater than those of carpet booms increases the probability of damage to either historic or prehistoric cultural properties. After all, the cultural properties of concern within the Valentine MOA could easily be impacted by overpressures which affect only 0.1 square mile or 64 acres. Admittedly, the chance of a focus boom impacting a cultural property is less than that of a more widespread carpet boom;

however, the greater overpressures associated with focus booms (Tables IV-4 and IV-5) are sufficiently large to induce instantaneous damage to the cultural properties.

e. Cumulative Effects

Although the predicted overpressures of 1 to 5 psf associated with Aerial Combat Maneuvering appear to be within the "safe" range as defined by the U.S. Bureau of Mines standards (Sedovic 1984; King et al. 1985), there remains the problem of attempting to assess the long term effect of repeated booms. The British studies (Warren 1972) on historic structures indicate that the level of vibration induced by sonic booms would be well below the level that would cause instantaneous damage; however, Warren (1972) recognized that the sonic booms would contribute to the processes that promote damage in the long term. Consequently, sonic boom effects must be evaluated along with other vibration-inducing environmental forces as well as other physical and chemical forces. Such conclusions are in accord with the statement of the Sonic Boom Panel of the International Civil Aviation Organization (1971):

> The notion of a 'lifetime' of a given structure may throw further light on the problem of sonic boom-induced damage. This is a new concept that is not yet commonly used by building engineers. Every structure accumulates damage (much of it not visible) from a variety of environmental conditions: wind loads, mechanically induced vibrations, temperature and humidity changes, weathering, general aging, etc. This may eventually terminate its life. Cumulative damage may therefore be referred to in a context approximating structural fatigue. The likelihood of visible damage owing to a sonic boom thus depends upon how far the structure is along its lifetime.
>
> A structure or structural element near the end of its lifetime would have a lowered threshold for damage and conversely. That is to say, the stress that will break a structural element is not invariable with time, but varies during its lifetime.

Unfortunately, the present data base provides very little information concerning the contribution of repeated sonic booms to the deterioration of unconventional or natural structures. Limited studies (Peschke et al. 1971; Kao 1970; Blume

Table IV-4

Focal Zone Areas for Fighter Turns

	10,000 Ft 0°		15,000 Ft 0°		30,000 Ft 0°		45,000 Ft 45°	
	P	A	P	A	P	A	P	A
F-4	5	0.36	Not		2.4	0.78	2.4	0.65
	11	0.0003	Calculated		6	0.001	4.8	0.006
F-15	5	0.21	4.1	0.2	2.4	0.75	Not	
	11	0.013	8.2	0.043	3.0	0.13	Calculated	
	13	0.00014						
F-16	4	0.241	3.3	0.15	1.9	0.346	Not	
	8	0.016	6.6	0.003	3.0	0.025	Calculated	

P = Pressure (psf)
A = Area (square miles)
Source: Plotkin 1985

Table IV-5

Focal Zone Areas for Fighter Acceleration

	10,000 Ft Level		15,000 Ft 10° dive		30,000 Ft 30° dive		45,000 Ft Level	
	P	A	P	A	P	A	P	A
F-4	7	1.8	7	0.70	5	0.45	No Focus	
	11	0.26	11	0.12	11	0.005	At Ground	
	16	0.16	16	0.003				
F-15	6	1.1	5	1.46	No Focus		2	1.26
	11	0.08	8	0.23	At Ground		5	0.33
	16	0.002	11	0.055				
F-16	5	1.0	5	0.43	4	0.36	2	1.28
	11	0.023	11	0.0045	8	0.005	4	0.218

P = Pressure (psf)
A = Area (square miles)
Source: Plotkin 1985

1965) concerning the effect of repeated exposure of conventional structures to sonic booms of less than 3 psf have yielded conflicting results. The White Sands Missile Range study which involved 680 successive flights at a scheduled overpressure of 5.0 psf resulted in the conclusion that no cumulative effect was identifiable (Blume et al. 1965). An experimental simulator study by Kao (1970) which subjected window glass to repeated overpressures ranging from 4 psf to 20 psf confirmed the Blume et al. (1965) study findings that a cumulative effect was not identifiable at overpressures less than 5.0 psf. Another simulated experiment (Peschke et al. 1971), however, resulted in contradictory findings. The results of tests involving repetitive (500 times) exposure of the wood frame, plaster wall panels to 1 to 5 psf overpressures indicate that cracking can occur at overpressures of 1 psf. The failure of the plaster was progressive and crack propagation was observed at overpressures below 2 psf. It is noteworthy that most of this cracking was evident only under examination with the aid of ultraviolet light; nevertheless, this study provides experimental evidence of structural weakening when materials are exposed to repeated sonic boom occurrences. A more recent experimental study by the Institute for Aerospace Studies (Leigh 1975) in Toronto, however, demonstrated that prestressed plaster panels would have a virtually infinite life under repeated exposure to overpressures of 10 psf. Such conflicting results related to modern or conventional materials raise serious questions concerning the technological expertise available to evaluate the damage threshold of aged, nonconventional structures submitted to repeated sonic boom exposures.

2. Assessment of Potential Effects

The cultural resources within the Valentine MOA exhibit differing physical characteristics which will affect their response to sonic boom induced airblasts and ground vibrations. For example, the presence or absence of extant structures and the context of the site (whether a buried alluvial site, rockshelter, or rock art site) are directly related to the potential impact of sonic booms. Five classes of cultural resources with different potential for sonic boom damage have been defined. These classes are: (a) buried sites; (b)

surface or low profile sites, (c) extant structures, (d) rockshelters, and (e) rock art sites.

a. Class 1 - Buried Sites

Since the impact of sonic booms is attenuated rapidly with increasing depth, subsurface archeological deposits such as buried alluvial sites and caches, and mines are least likely to be affected by sonic boom impacts. No direct impact is anticipated.

b. Class 2 - Surface or Low Profile Sites

This class of cultural resources includes surface artifact scatters, burned rock middens, ring middens, hearthfields, quarries, historic cemeteries, smelter operations, fences, corrals, and other historic features related to transportation or ranching. Although these resources are more exposed to sonic boom impact, their low profile in relation to airblasts and their resilient physical properties relegates the potential for direct impact almost negligible.

c. Class 3 - Extant Structures

Within the Valentine MOA extant structures are represented only for the historic period. Farmsteads, homes, cotton gins, churches, stage stations, and forts are represented. Building types may include the following: (1) rubble rock (undressed rock walls), (2) dressed rock walls, (3) adobe brick, (4) wooden frame, (5) brick, (6) corrugated sheet metal, (7) concrete block, (8) poured concrete, or combinations of the above. Except for a single church noted during reconnaissance, the extant structures within the Valentine MOA are single story or have collapsed. Although their relatively low profiles makes them less susceptible to sonic boom damage, two categories, based on vibration characteristics are recognized. The first category includes those structures most likely to be affected by sonic booms. Buildings constructed of stiff or brittle materials such as stone, brick, adobe bricks, or concrete blocks are included in this category. The potential for damage of these structures is

further increased by their generally poor condition due to abandonment and a lack of maintenance. The second category consists of buildings with more resilient facades (e.g. wood) and a stronger structure (intersecting walls, solid rather than block construction). The potential for damage is reduced further if the structure has been well maintained.

d. Class 4 - Rockshelters

Topographically, rockshelters within the Valentine MOA are situated at high altitudes within geological settings which may be sensitive to potential damage from rock falls or landslides which could be induced by sonic boom vibrations. Numerous rockshelters which are potentially eligible for nomination to the National Register of Historic Places exist within the Valentine MOA.

e. Class 5 - Rock Art Sites

Petroglyphs and pictographs occur on the surfaces of boulders, rock outcrops, and rockshelter walls within the Valentine MOA. Theoretically, airblasts or vibrations from sonic booms may induce more rapid deterioration of such surfaces. More fragile formations, such as volcanic tuff, or rock surfaces which are already exfoliating are likely most vulnerable to sonic boom impact.

Of the cultural resources within the Valentine MOA, the potential impact of the sonic booms is of greatest concern in relation to the rockshelters and rock art sites. Although a systematic survey for extant structures has not been conducted, most of these structures are either along the periphery of the MOA or near population centers which will be avoided. From the present evidence, instantaneous damage to the more sensitive Class 4 and 5 sites, and even to the Class 3 (extant structures), is not likely given overpressures of 1 to 3 psf. The cumulative effect of repeated exposure of the Class 4 and 5 sites to sonic booms, however, is unknown.

3. Recommendations

The following recommendations are based upon the information presently available. It should be noted that the recent monitoring study of the sonic booms produced by Air Combat Maneuvering activity over White Sands Missile Range has provided data critical to the assessment of the potential impact of sonic booms on cultural resources.

Twenty-five years of research concerning the structural damage caused by sonic booms has been largely limited to studies for nominal overpressures up to 30 psf. These studies have indicated: (1) "building structures in good repair should not be damaged at boom overpressures less than about 11 lb/ft^2..." (Clarkson and Mayes 1972), (2) damage from 6 psf nominal booms is considered to be a rare occurrence (10^{-5} to 10^{-2} broken windows per window-boom exposure) and quite minor in scope, (3) the damage rate will increase by 2 to 3 orders of magnitude for each doubling of sonic boom pressures up to 30 psf, and (4) cumulative minor damage effects from repeated exposure to low amplitude (ca. 2 psf) booms has not been evident in extended sonic boom tests. Unfortunately, these conclusions have been largely derived from studies of modern structures and sonic booms produced by straight-line overflights; consequently, questions concerning the overpressures produced (both carpet and focus booms) by air combat maneuvering activity and the potential damage to a wide range of special or unconventional structures such as archeological sites or older historic buildings remain.

Limited monitoring projects within the Reserve (Fengler and Bishop 1986) and Valentine (Battis 1983) MOAs and the recent extended monitoring of ACM activity over WSMR provide the data most relevant to these concerns. Monitoring of Air Combat Maneuvering (ACM) activity over the Reserve MOA resulted in the recording of only 11 sonic booms for 72 supersonic sorties. The average overpressure for these booms was 0.8 psf. These figures are clearly lower than previously predicted for such flights. It was also determined that focus booms would occur at a rate of 0.0003 per site per day or approximately once in 1.4 years. The limited number of booms recorded provided data with uncertain statistical

significance; however, it did show that the Oceana sonic boom model overpredicted the frequency and magnitude of sonic booms. The special studies conducted in the Valentine MOA to observe effects on rockshelters and rock art also provided limited data to discuss thresholds of potential impacts because overpressure levels of induced sonic booms were barely above the detection capabiilty of the instrumentation used to monitor the overpressures. Both studies, however, provided historical data which indicated that atmospheric conditions tend to lessen the impacts from that which is predicted by theoretical models.

The recent monitoring of ACM activity at WSMR between July 1988 and January 1989 has provided data essential to the resolution of such questions. The WSMR monitoring study verifies that the overpressure values derived from these limited studies are more representative then those derived through previous modeling efforts. During the six month monitoring period, there were 4600 ACM sorties. A total of 591 sonic boom events were recorded. Each boom was typically recorded at three or four locations. The average peak overpressure was 0.673 psf (Table IV-6). The average maximum peak overpressure was 3.523 psf. These low values indicate that the potential impact on the archeological and historical resources would be significantly less than that previously anticipated. Even though the archeological and historical resources are more fragile than most of the structures subjected to sonic boom studies, it is apparent that overpressures of one to three psf are significantly lower than the levels generally accepted as capable of damaging modern structures.

The potential damage of sonic booms to unconventional structures or natural structures is not as well documented as for conventional structures. The limited number of studies (Clarkson and Mayes 1972; Warren 1972; USAF 1979; Battis 1981; King et al. 1985) available, however, support the conclusion that such structures may be less sensitive than popularly thought. Unfortunately, these studies do not provide specific levels at which historic structures or archeological resources will be negatively affected by sonic boom activity. A consensus concerning a safe level of ground motion associated with historic structures remains to be reached. Bureau of Mines studies (Siskind et al.

Table IV-6

White Sands Boom Monitoring Project
(July 1988 to January 1989)

Site No.	Time Up (Days)	No. of Records	Records Per Day	CDNL (dB)	Avg Lpk (psf)	Max Lpk (psf)	Min Lpk (psf)	Std Dev (psf)	Variance (psf)
2	122.5	48	.39	51.8	.611	7.195	.096	1.106	1.223
3	177.9	55	.31	47.0	.580	4.416	.279	.597	.356
4	154.2	85	.55	52.5	.649	2.619	.099	.646	.417
5	103.5	34	.33	46.4	.668	3.686	.110	.712	.507
7	146.1	12	.08	40.4	.641	1.588	.195	.462	.213
8	166.2	41	.25	53.2	.590	4.416	.248	.743	.552
9	177.1	123	.69	51.7	.687	4.216	.094	.720	.519
10	169.9	74	.44	51.4	.820	3.936	.248	.743	.552
11	143.8	50	.35	46.7	.585	2.598	.099	.592	.351
12	191.3	63	.33	52.3	.540	1.396	.248	.297	.088
13	155.4	84	.54	53.0	.916	5.148	.263	.873	.761
14	189.9	108	.57	55.7	1.151	6.669	.099	1.251	1.565
15	171.2	90	.53	53.6	.991	4.414	.108	1.003	1.005
17	174.2	102	.59	56.9	.742	5.248	.248	.779	.606
18	148.1	43	.29	49.1	.785	3.758	.096	.781	.610
19	186.0	101	.54	52.4	.884	6.607	.234	.945	.893
20	188.4	112	.59	51.3	.737	2.786	.248	.598	.358
21	176.1	122	.69	54.3	.988	5.208	.108	.856	.732
22	145.5	92	.63	50.1	.639	2.725	.042	.654	.427
23	171.0	120	.70	54.1	.933	4.423	.101	.998	.997
24	182.0	79	.43	58.0	.672	1.862	.234	.438	.192
25	181.4	42	.23	43.3	.647	3.126	.248	.558	.311
26	160.2	65	.41	45.0	.545	2.786	.248	.488	.238
27	177.5	99	.56	54.7	.582	5.888	.248	.740	.548
28	117.3	13	.11	38.4	.525	2.213	.263	.519	.270
29	167.6	67	.40	46.7	.636	3.406	.101	.613	.376
30	179.0	59	.33	42.9	.415	2.239	.099	.420	.176
31	108.8	10	.09	38.7	.513	1.299	.214	.380	.144
32	149.4	68	.46	51.1	.720	5.118	.103	.937	.878
33	55.1	9	.16	43.6	.642	1.972	.279	.523	.273
34	148.4	36	.24	42.2	.479	1.764	.101	.381	.146
35	184.7	80	.43	46.4	.523	2.877	.087	.488	.239
36	172.9	25	.14	40.8	.543	2.213	.263	.420	.178
37	156.5	35	.22	37.1	.432	.989	.248	.192	.037
38	137.5	13	.09	37.5	.543	2.387	.132	.618	.382
Total Records		2259							
Ave. Recs/Day			.39						
Ave. Lpk					.673				
Ave. Max Lpk						3.523			
Ave. Min Lpk							.175		

Source: Wyle 1989

1980a) indicate that a safe level of ground motion for dwellings is in the range of 2.0 to 3.8 mm/second. Ashley (1976), on the other hand, proposed peak particle velocities of 7.5 mm and 12 mm for ancient and historic monuments and housing in poor repair, respectively. King et al. (1985) in their vibration hazard investigations of Chaco Canyon National Historical Park note European standards of 2.0 to 2.5 mm/second as a safe level for historic structures. King et al. (1985) concur with this perspective and recommend a 2.0 mm/sec particle velocity to be the upper limit for induced motions in structures. Studies by Goforth and McDonald (1968) and Battis (1981) indicate that sonic boom overpressures of less than 5 psf will result in particle velocities within this safe range. Consequently, if the overpressures resulting from Air Tactical Maneuvering are within the 1-3 psf range as indicated by the Fengler and Bishop (1986) study and the 1988 WSMR study, there will be no instantaneous impact to any of the classes of historic and archeological resources with the Valentine MOA.

The cumulative impact of repeated sonic booms to the deterioration of unconventional or natural structures, however, is not easily assessed. The recent data collected at WSMR indicate that the average maximum peak overpressure (3.523 psf) is well within the safe range and therefore the cumulative impact should be negligible over even an extended period of time. The low probability of a boom overpressure being greater than 5 psf (Figure IV-6) together with the extremely low probability of boom reoccurrence at a given point in space renders the potential for cumulative damage to be extremely low.

H. Socioeconomic Conditions

1. Economic Considerations

The continuing issues regarding the impact of supersonic flight training in the Valentine MOA remains to be the potential for disturbance of the housing market and the sensitivity of the existing and future residents in the Valentine and in the Fort Davis and Davis Mountain areas. This issue was identified and addressed in the 1980 environmental impact statement for the area, and attempts

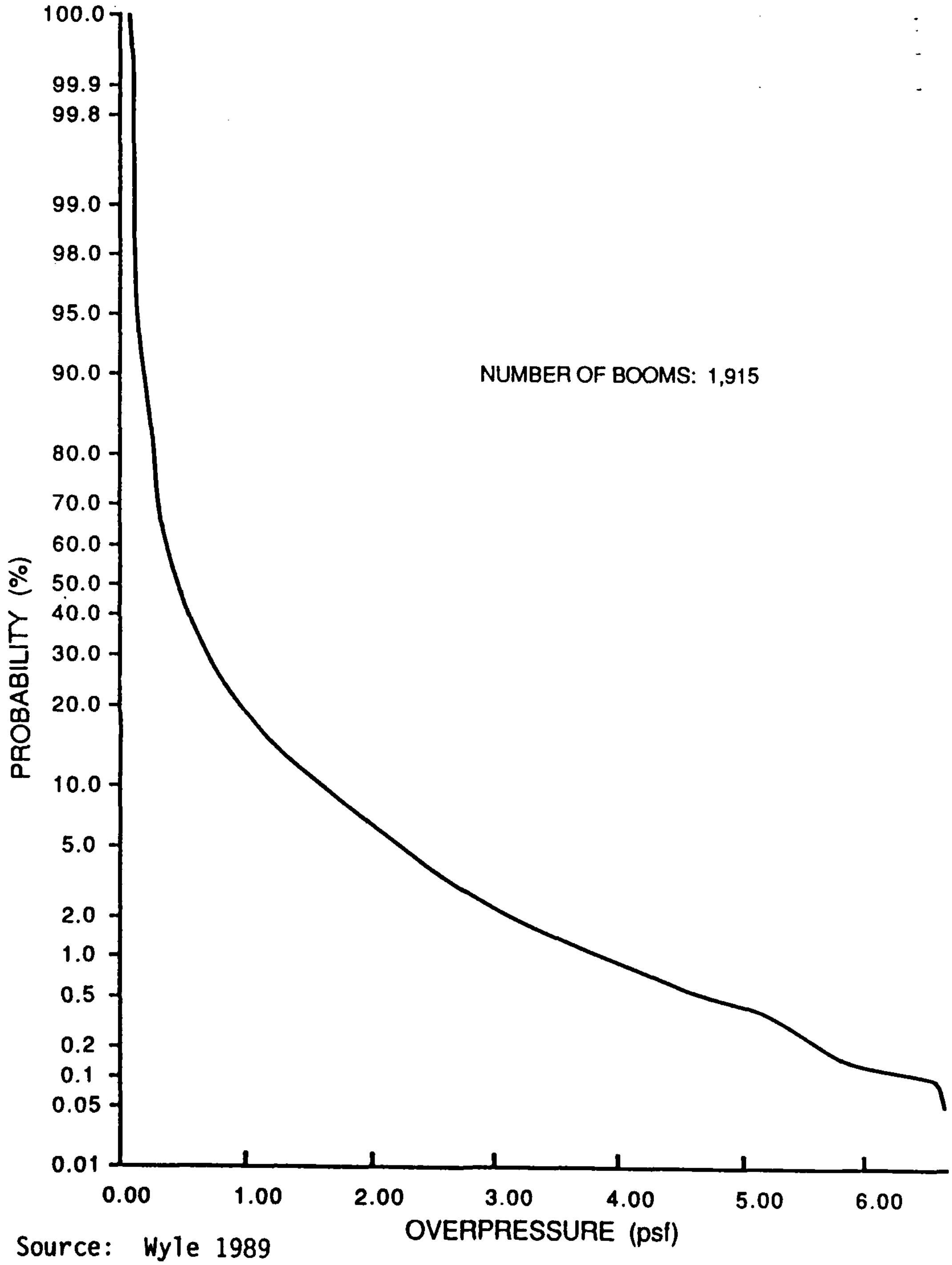


FIGURE IV-6 Cumulative Distribution for Overpressures of All Recorded ACM Sonic Booms.

were made to identify probable impacts on that segment of the economy. The source utilized was the study "Economic Impact Study: Valentine and Reserve Military Operations Areas," 1980, and related studies at White Sands, New Mexico, Gladden and Sells, Arizona, and Desert, Nevada. That analysis indicated that resulting sonic booms in no way affected retirement home development, recreation, or tourism. In addition, it was found that sonic booms created no significant socioeconomic impact.

2. Populations

Study of the four identified military operations areas and the effects of sonic booms on population growth has yielded no significant impact in those areas. The 1980 assessment indicated that no significant impact was expected in the Valentine MOA on population growth. Because of recent development proposals in the area and of continuing development in the Fort Davis area, there is no indication that any impact is evident. The growth projected in Jeff Davis County is expected to include an additional 800 to 820 persons by the year 2030. It is evident that such growth is contingent upon continued development and is subject to market demands. Should the expected growth occur, it is expected that no significant impacts resulting from supersonic flight training in the Valentine MOA will be incurred.

3. Employment

It is not expected that the balance of employment in ranching, agriculture, construction, retail, and service segments will be altered in the foreseeable future. The markets in the area are sensitive to outside forces, including price fluctuations, oil supply and demand, market fluctuations, trends in disposable personal income, import/export levels, and a range of other forces outside the control of the area. These forces will define future employment pictures and distributions in the future. The operations contemplated at the Valentine MOA should not have any significant effect on the local employment picture.

4. Personal Income

It is not anticipated that the proposed operations will have any significant impact on personal income of the area. The operations will create no income, direct or otherwise, for the area. The operations will not impact other segments of the economy critical to the determination of personal income, such as population, employment, new business growth, housing markets, service delivery, or other determinants. The anticipated action will create no jobs, add no tax base, require no service or material goods, require no housing, or create any identifiable economic impact.

5. Retail Trade

It is not expected that the proposed action would have any significant beneficial or detrimental impact on the development or maintenance of retail trade. This is evident from experience in other MOA's and the viability of the local retail segment would seem to further that conclusion. Sonic boom activity has not proven to be detrimental to retail trade; in fact, retail levels in other MOA's have shown significant increases.

6. Assessed Evaluation

There has been no evidence that sonic boom activity will in any way affect changes in assessed valuation in other MOAs. No significant impact on the Valentine MOA or the Jeff Davis County assessed valuation is expected to result from the proposed supersonic training flights.

7. Real Estate Development

It is not expected that the proposed action will have significant effect on the real estate development market. The generation of sonic booms and related activity has not shown deleterious effect on property values or real estate markets to date. With the trend to large-lot markets, high population densities and concentrations do not exist. Much of the building is in the retirement and

second home markets which continues to thrive in this area. However, analysis of sonic boom activity on local real estate development and markets indicates that no significant impact can be expected. In fact, most markets observed have continued to operate normally.

8. Recreation and Tourism

It is not expected that the proposed activity will significantly impact recreation or tourism in the area. In similar MOAs tourism declined primarily due to fuel costs and remoteness of the sites. No indication has been found that would indicate that sonic boom activity would adversely impact recreation and tourism industries.

9. Ranching

The review of ranching operations in four other MOAs has not produced any indication that impacts from sonic boom activity are detrimental. Generally, ranching in the WSMR MOA has been steadily increasing. However, some decline was attributable to the availability of beef cattle, but no decreases were attributable to the presence of sonic booms. It is not expected that the production of sonic booms will have any significant impact on ranching operations or the cattle industry as a whole in Jeff Davis County.

10. Farming

It is not expected that the proposed action will have any significant impact on this small segment of the overall county economy. Although, the effect of sonic booms on farming activity has not been established, it is not likely that there is any correlation of significant impact to alter farm production in the county.

11. Mining

Because of the total decline of the oil production in Jeff Davis County and because of lack of evidence from other MOAs that the production of sonic booms

impact the mining industry, it is not expected that sonic booms will have any significant impact on the mining sector of the economy.

12. Forestry

There is no evidence that forestry has become a significant economic contribution in the period since 1980, and it is not expected that sonic boom activity would have any significant effect. There has been no forestry activity in any of the four MOAs examined, and impact of sonic booms on that industry is undetermined.

I. Water Resources

The proposed action of supersonic training in the Valentine MOA will not impact water resources at or around the MOA. The nature of the training does not require any water consumption. Water supplies are more than adequate to meet the demands of fire fighting support necessitated by plane crashes on rare occasions. However, during rare emergencies, it may be necessary to jettison fuel over the MOA. Still the expelled fuel is not a threat to local surface or ground water since, if jettisoned at or above 15,000 ft. MSL, the fuel would evaporate long before reaching ground level.

J. Solid Waste/Hazardous Waste-Materials

There is no solid waste associated with training at the Valentine MOA and therefore no adverse impact anticipated. Particulate and gaseous emissions from aircraft operation have been estimated for the Valentine Training Mission (see Table IV-1). Mixing and dispersion under the existing conditions would insure more than sufficient emission dilution before reaching ground level. Any jet fuel jettisoned at normal operating elevations during an emergency would be highly aspirated and evaporated long before reaching the ground.

K. Energy Conservation Potential

The 49th TFW would prefer to fly all supersonic sorties at WSMR but the ongoing research and development missions at WSMR prevent this. The selection of Valentine and Reserve MOA as alternate supersonic training sites as opposed to more distant locations is at least partially in the interest of fuel economy. The fuel used in military aircraft is a resource that is both irreversible and irretrievable but the use is consistent with national policy.

L. Airspace Impacts

Private aircraft would not be prohibited from use of the Valentine MOA airspace. The airspace is under the control of the FAA at Albuquerque ARTCC, Albuquerque, New Mexico. Supersonic training will not result in special procedures or operating limitations being placed on private aircraft. The proposed action was reviewed by the Texas Aeronautics Commission (1978) and the following comments provided: "The proposed Marfa-Van Horn (Valentine) MOA probably contains the lowest combination of population density and commercial air traffic in the State. The majority of air traffic in the MOA will be general aviation commuting to ranches in the area and in transit between the Marfa-Alpine and El Paso areas. Presidio, approximately 50 miles south of the MOA, is an official customs point of entry and will produce some GA (General Aviation) traffic mostly in the northeast - southeast direction. The majority of the GA traffic will operate below 15,000 ft. MSL." The Valentine MOA is depicted on the El Paso Sectional Aeronautical Chart to warn general aviation pilots of the specific utilization of the area by military aircraft. The proposed supersonic training sorties within the Valentine MOA should have minimal impact on general aviation in the area.

V. ALTERNATIVES TO THE PROPOSED ACTION

A. Background

1. General

For optimum combat capability, the 49th TFW needs sufficient airspace to fly 1,200 sorties per month, during which supersonic flight may occur. Existing areas in the vicinity of Holloman AFB cannot accommodate all the monthly 49th TFW supersonic sortie requirements. It is anticipated that WSMR will continue to support about 600 supersonic sorties per month on a long term basis. As the WSMR testing schedule allows, the 49th TFW may be able to fly more than 600 supersonic sorties per month in the WSMR airspace; however, the additional sortie capability (above 600 per month) will be variable and cannot be counted on in terms of national defense. To accomplish the air superiority mission, the 49th TFW needs additional supersonic airspace capable of handling a maximum of 600 sorties per month. Depending upon the airspace size, availability, location and environmental consequences, all 600 sorties potentially could be flown in one area or divided between several areas. A maximum of three hundred sorties per month are proposed at the Valentine MOA.

2. Alternative Consideration

These alternatives are the same as those presented in the Environmental Impact Statement which was completed in 1984. These alternatives have been reevaluated based on present information and latest data available. Alternatives selected in order to meet the 600 sortie shortfall consider the following basic categories: (1) utilize existing MOAs within 150 NM of Holloman AFB, (2) utilize existing supersonic airspace outside 150 NM of Holloman AFB by air refueling or temporarily deploying aircraft to another base, (3) create a new MOA capable of handling supersonic operations within 150 NM of Holloman AFB, and (4) the no action alternative.

3. MOA Selection Criterion

Requirements and guidelines for MOA selection are as follows:

a. As required by Air Force and FAA regulations, the area should be located in airspace transitted by few commercial airways and servicing limited established airports and general aviation traffic, thus, avoiding/minimizing the impact which military flight operations may have on other airspace users.

b. The area should be very sparsely populated so that the fewest number of people are affected by the potential noise impacts resulting from supersonic flight activity.

c. The size of the area must be large enough to allow effective use of the F-15 long-range radar and associated weapons systems. The F-15 radar can acquire targets which are in excess of 80 NM away. When flights are conducted in small operating areas, where the maximum separation available between aircraft is less than 30 NM, the pilot is unable to exploit the full capability of the F-15 weapons systems. Large areas also enhance realistic tactical missions by providing additional airspace for adversary aircraft to evasively maneuver to avoid F-15 radar detection. Based on previous operational experience, the minimum area size to accomplish effective F-15 missions is 40 x 50 NM.

d. The proposed supersonic sorties should not replace any existing operations. Operational altitudes available for the area must be low enough to accommodate realistic missions but not so low as to conflict with effective air route traffic control and general aviation traffic. In addition, since ground sonic boom effects are inversely proportional to the altitude of the aircraft above the ground, the minimum operational altitudes must be a compromise to allow realistic scenarios while minimizing the sonic boom effects on the public beneath the airspace. Altitudes of the areas discussed are illustrated in Figure V-1.

B. Alternative Evaluation

1. Utilize Existing Airspace Within 150 NM of Holloman AFB

The reason for locating the area within 150 NM of Holloman is to minimize time and fuel required in transit to and from the area. Based on an area located 150 NM from Holloman, F-15s expend approximately 850 gallons of fuel (round trip), leaving approximately 1,200 gallons of fuel or about 30 minutes of flying

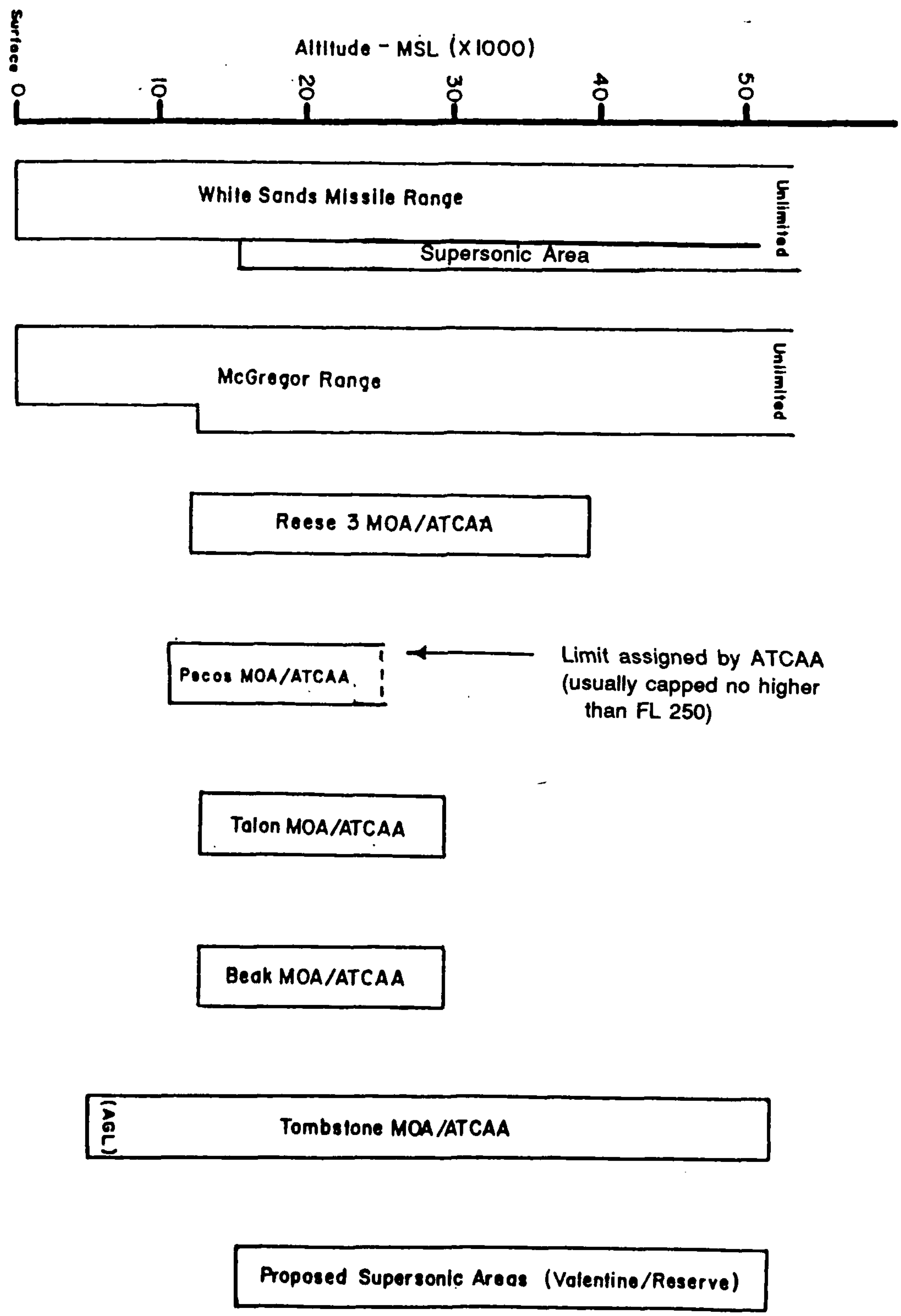


FIGURE V-1 MOA Operating Altitudes

time available for tactical flying in the area. Any area located in excess of 150 NM would increase transit time and fuel required, resulting in less tactical flying time. This waste of time and fuel should be minimized from a cost effective/operational standpoint.

All military flying areas, except WSMR areas, located within 150 NM of Holloman AFB were evaluated for potential supersonic flight using the above selection criteria. Additionally, the airspace was examined to determine if any location would be suitable for establishing a new supersonic military operations area. Figure V-2 depicts the commercial airways, and existing military areas within 150 NM of Holloman AFB. Analysis for each of the alternate areas located within this airspace follows.

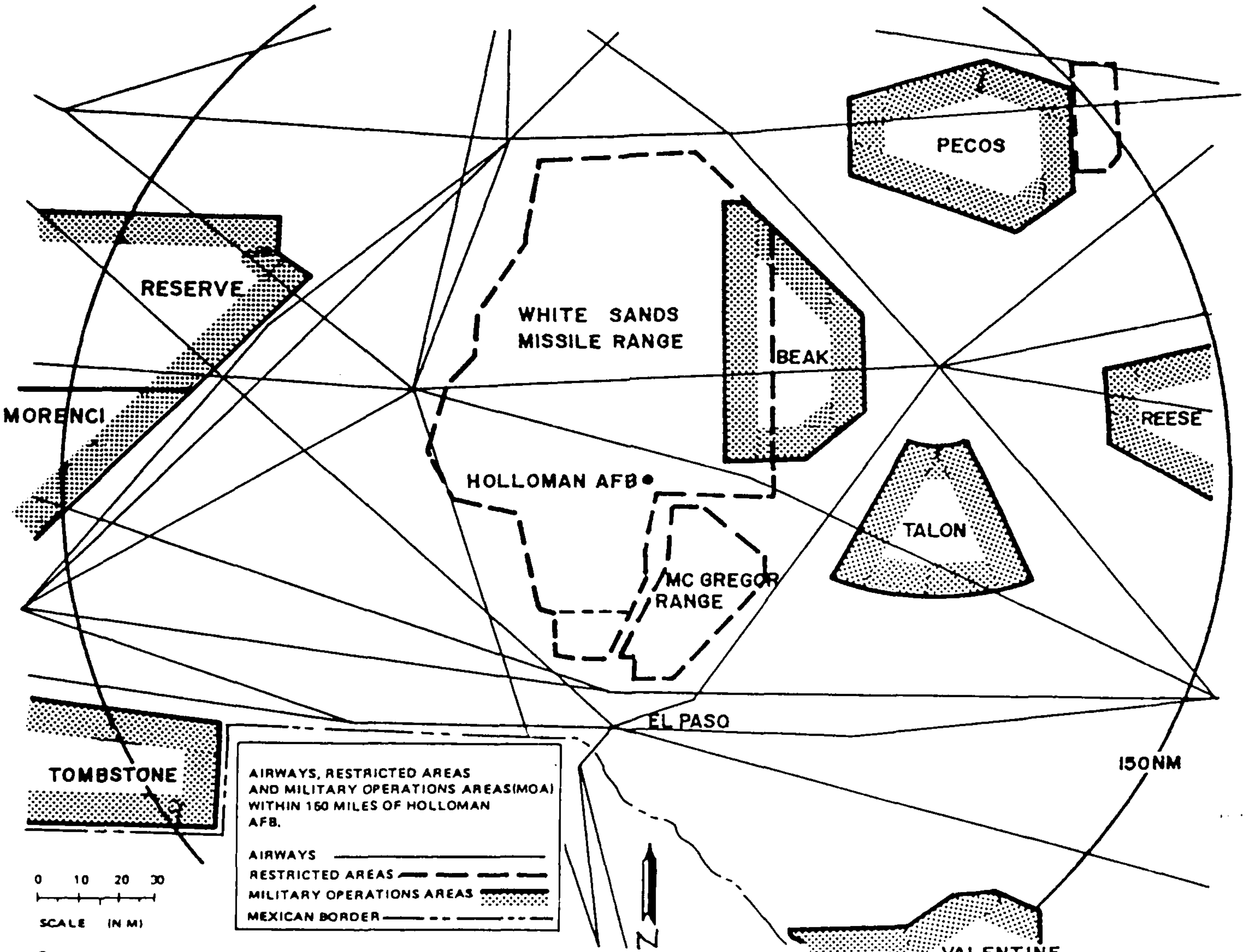
a. Beak Military Operations Areas

The Beak areas are located 30-80 NM east/northeast of Holloman Air Force Base. Although the size of the area is adequate, the population beneath the Beak MOA area is: Cloudcroft -- 521; Mescalero -- 900; and Ruidoso -- 4,260 (Rand McNally 1988).

Numerous other smaller communities such as Lincoln, Capitan, and Fort Stanton are also located beneath the Beak MOAs. The Beak MOAs are used primarily for 479th TTW T-38 flight operations. Loss of these areas for T-38 training would seriously degrade the mission of the 479th TTW.

b. Talon Military Operations Area

The Talon MOA is located approximately 60-100 NM east of Holloman AFB. The population density beneath most of the airspace is low. Because of the commercial air traffic route over the area, the maximum altitude available is 29,000 ft. MSL which would be marginal for F-15 training. Even if the upper altitude could be raised to 51,000 ft. MSL and commercial air traffic could be rerouted around the area, F-15 supersonic flight requirements could not be accommodated. In May 1980, the 479th TTW in coordination with the FAA changed



Source: U.S. Air Force 1979a

FIGURE V-2 Airways, Restricted Areas and Military Operations Areas (MOA) Within 150 Nautical Miles of Holloman AFB

the Talon MOA boundaries in order to divide the MOA into three separate working areas. This action caused the MOA to shift to the northeast since the area's boundaries are now defined by the Roswell navigation aid. The cities of Artesia (population 10,385) and Carlsbad (population 25,496) are now within the borders of the MOA (Rand McNally 1988). If the boundaries were expanded to the previous borders and a five mile buffer were placed around each of these cities and Carlsbad Cavern National Park, the resulting area available for supersonic operations in the Talon MOA would be 20 x 30 NM. This is too small for suitable F-15 supersonic flights. Another major disadvantage associated with using the Talon MOA for F-15 missions is the fact that it is used extensively for T-38 flight operations. Due to the large number of T-38 sorties, Talon MOA and Beak MOA are vital areas for accomplishment of the 479th TTW flying mission.

c. R-5103 McGregor

The McGregor Area (Restricted Area 5103) is located 15 NM southeast of Holloman and 16 NM northeast of El Paso, Texas, metropolitan area (population 350,000). The airspace managed by the U.S. Army at Ft. Bliss, Texas, is divided into three areas (R-5103 A, B and C). All three areas are used extensively for Army surface-to-surface/surface-to-air missile and gunnery training. To provide increased local airspace for T-38 flying, Holloman AFB has a letter of agreement with the Army which allows T-38 usage of R-5103C airspace for approximately 18-20 hours per week. R-5103C, the airspace north of N32°15'00", is the only portion of R-5103 that Air Force aircraft are allowed to fly. This northern area is approximately 15 x 30 NM and is consequently too small for useful F-15 supersonic activity. In addition, the limited scheduling basis also makes the airspace unsuitable for consideration as a F-15 supersonic flight area. Even if more time were available to Holloman in the McGregor area, as with the Beak and Talon MOAs, all subsonic airspace within 90 NM of Holloman must be dedicated to T-38 flight operations due to the aircraft's short operating range and high daily sortie rate.

d. Pecos Military Operations Area

The subsonic Pecos MOA is approximately 120 NM northeast of Holloman AFB. The airspace is managed by Cannon AFB, located at Clovis, New Mexico. Although Pecos is Cannon's only MOA, approximately 3-4 hours per day would be available for F-15 shared usage.

The area is large enough to accommodate F-15 supersonic flights; however, the present vertical dimension is limited, extending from 10,500 ft. MSL to the limit set by ATCAA (usally capped at FL 250). It is possible that the maximum altitude of the areas could be increased. This action would require several changes to the existing high altitude structure above the MOA. First, extensive commercial air carrier traffic operating on the high altitude jet route (J-74) which presently transits the MOA would have to be re-routed around the area when flying is in progress. J-74 is the preferred east-west route between Los Angeles/San Diego and Dallas-Ft. Worth/Atlanta by the FAA and commercial carriers (airlines). The re-routing could be accomplished by Air Route Traffic control vectors or by physically moving the airway clear of the Pecos airspace. This re-routing would result in increased flight time and increased fuel costs for the commercial carriers.

Secondly, increasing the maximum available altitude in the Pecos MOA would require restricted use or a complete relocation of the refueling track which presently overlies the Pecos area. Besides the existing airway and refueling track conflicts mentioned above, the major difference between the Pecos and Valentine MOAs is population. Because the population of the Pecos MOA (2,000) is greater than twice that of the Valentine MOA (700), more area residents would be affected by sonic boom activity in the Pecos area for a given number of F-15 supersonic sorties, as compared to the Valentine area.

e. Reese 3 Military Operations Area

The Reese 3 MOA is located approximately 130 NM east of Holloman AFB. Extensive T-38 training from Reese AFB is conducted in the MOA and little scheduling

flexibility would be available for F-15 sorties. Less than four hours per day would be available for shared usage of the area. Sonic booms would affect a large number of people residing near the MOA in the cities of Tatum (population 896), Lovington (population 9,727), Hobbs (population 28,794), Denver City (population 4,704), and Seminole (population 6,080) (Rand McNally 1988).

f. Reserve Military Operations Area

The Reserve MOA is located approximately 120 NM west northwest of Holloman AFB. Although three airways transit the area, it is geographically large with vertical altitudes ranging from 5,000 ft. above ground level to 51,000 ft. mean sea level. Approximately six to eight hours daily are available for F-15 shared use. The area has no established airports with hard surfaced runways and minimum general aviation traffic. Although the supersonic portion of the area is relatively small (33-47 miles) the large overall size of the adjoining subsonic portions of the area allows effective utilization of the long range F-15 radar system. Mission scenarios can be planned so that participating aircraft use the radar system to converge from the subsonic portions of the area to the supersonic section for visual air combat maneuvering. Only the northeastern corner of the area is proposed for supersonic flight to avoid to the maximum extent possible populated areas and designated wilderness areas beneath the remaining portion of the Reserve MOA. The area presently accommodates a maximum of 300 supersonic sorties per month or about half of the required F-15 supersonic flying sorties that must be flown outside the WSMR airspace.

g. Tombstone Military Operations Area

The Tombstone MOA is located about 135 NM southwest of Holloman. It is managed by the 355 TFW located at Davis-Monthan AFB in Tucson, Arizona. The subsonic MOA is used extensively by A-7, A-10, F-16, and various other military aircraft which operate from the Tucson area and would be available for less than two hours per day for F-15 use. Even if scheduling priority for the airspace could be given to F-15 sorties, the area is not large enough to effectively employ the F-15 weapons system. Due to numerous major airways along the northern border

and the Mexican border on the south, the possibility for expansion of the geographic area boundaries appears unlikely. The area has sparse population, which is desirable for supersonic flights; however, the existing utilization by Davis-Monthan aircraft and the small size make it an undesirable alternative for F-15 sorties.

h. Valentine Military Operations Area

The Valentine MOA is located 140 NM southeast of Holloman. At present, the 49th TFW (with the exception of limited use by the 67th TRW and U.S. Navy aircraft from Chase Field) is the sole user of this airspace. Consequently, no military shared use problems are encountered. F-15 area time would only be limited by the amount of daylight time available. There are no established airports with hard surfaced runways within the area and only limited general aviation traffic transits the area. The Valentine MOA is large with suitable vertical altitudes ranging from 15,000 ft. MSL to 51,000 ft. MSL. The population density is very low with only one small community (Valentine, population 213) located directly beneath the proposed airspace.

i. Summary of Comparisons

Table V-1 provides a review of the existing airspace in comparison to the criteria. The Valentine and Reserve MOAs most nearly satisfy all necessary physical requirements and criteria, pending only environmental review and approval from pertinent agencies and the general public.

2. Special Combined MOA Usage

Since only Valentine and Reserve MOAs satisfy the physical Air Force and FAA requirements within 150 NM of Holloman, joint usage with WSMR to satisfy the 49th TFW mission is a logical alternative.

TABLE V-1

Comparative Review of Existing Airspace Within
150 NM of Holloman AFB, New Mexico

EXISTING AIRSPACE	COMMERCIAL AIRWAY IMPACT	SPARSELY POPULATED	SIZE GREATER THAN 40 X 50 NM	NO EXISTING MISSION IMPACT
Beak MOA	-	-	*	-
Talon MOA	-	-	-	-
R-5103 McGregor	*	*	_	-
Pecos MOA	-	-	*	-
Reese 3 MOA	-	-	*	-
Reserve MOA	-	*	*	*
Tombstone MOA	*	*	-	-
Valentine MOA	*	*	*	*

*No impact

Source: U.S. Air Force 1979; Geo-Marine, Inc.

a. Utilize Only the White Sands Missile Range and the Reserve MOA for Supersonic Operations

If the magnitude of existing military and civilian flight activity in the Reserve MOA would not support significantly increased F-15 flight operations above the projected 300 sorties, then only when WSMR could accommodate 900 sorties a month would the 49th TFW meet proficiency objectives of 1200 sorties per month.

(1) Reserve MOA Contingencies

The 162nd Tactical Fighter Group, Air National Guard at Tucson, Arizona, is the scheduling authority for the Reserve MOA. The area is used extensively on a shared use basis by numerous military units stationed throughout the southwest U.S. Any increase in F-15 sorties to the area above the projected 300 sorties per month would result in decreased availability of the airspace for other military/civilian organizations. Three high altitude jet airways (Figure V-2) which define major commercial air carrier routes from the West Coast to the south central portion of the United States, presently transit the Reserve MOA. When F-15 aircraft use the higher portions of the airspace where commercial air carrier routes are normally flown, commercial air traffic must be routed away from the affected airways to avoid the MOA. The rerouting results in increased flight time and increased fuel costs for the commercial carrier.

Assuming the Reserve area is used for supersonic flights and the problems associated with increasing the number of F-15 sorties to the area could be resolved, the environmental impact of the aircraft noise and sonic booms would be as shown in Figures V-3 and V-4 (300 sorties per month). Figure V-3 shows the relative long-term average "c-weighted" day night noise level for the CDNL 45 ellipse. If operations were raised to 600 sorties per month, the noise levels shown in Figure V-3 would be about three decibels higher. At this volume of activity, the 50 dB level would be approached along with the threshold of public annoyance. Splitting the operations equally between WSMR and Reserve would help reduce the number of people under the WSMR airspace that are highly annoyed. Currently there are about 150 people living under the WSMR supersonic airspace.

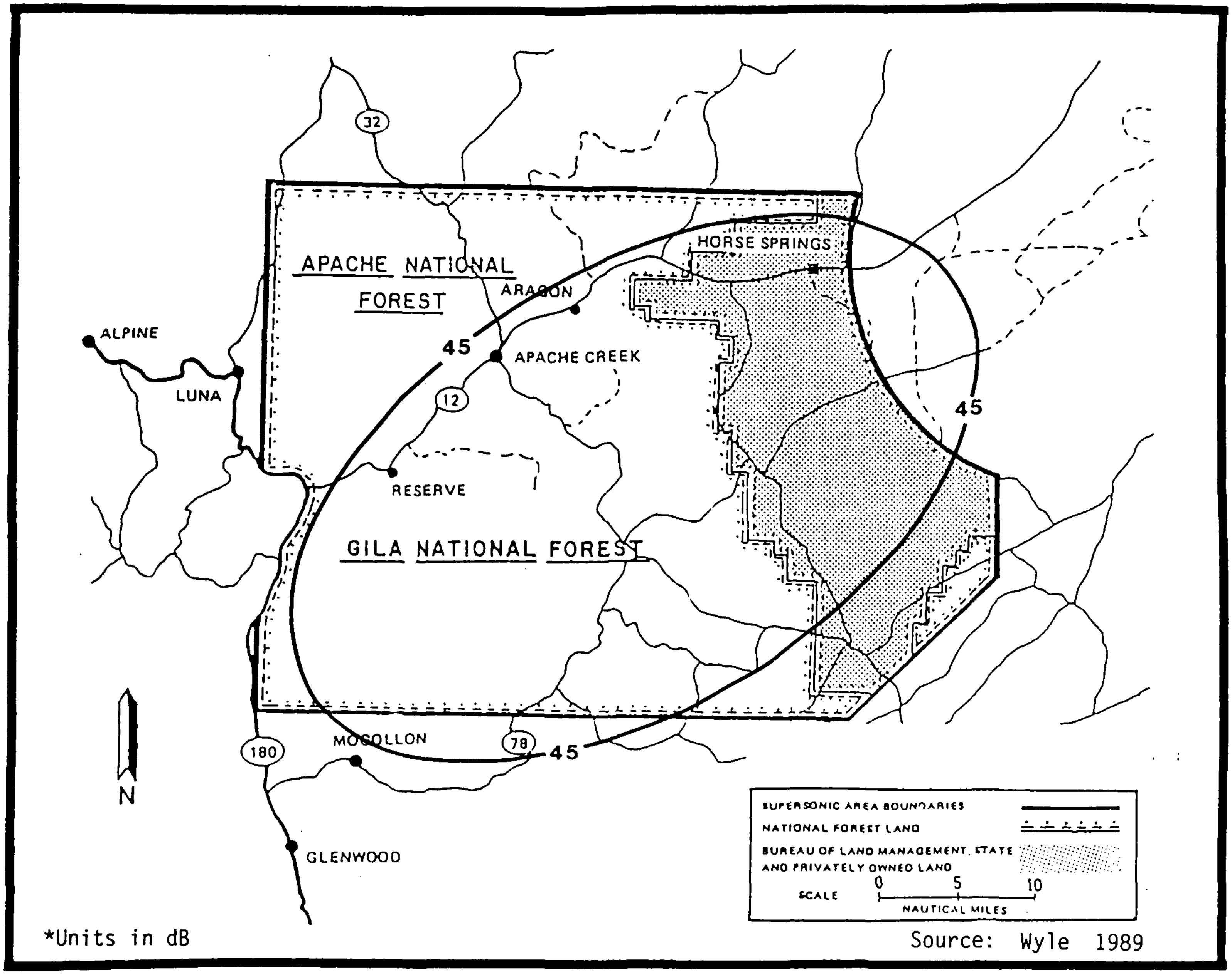


FIGURE V-3 C-Weighted Day Night Noise Level Distribution at Reserve MOA Based on WSMR Model.

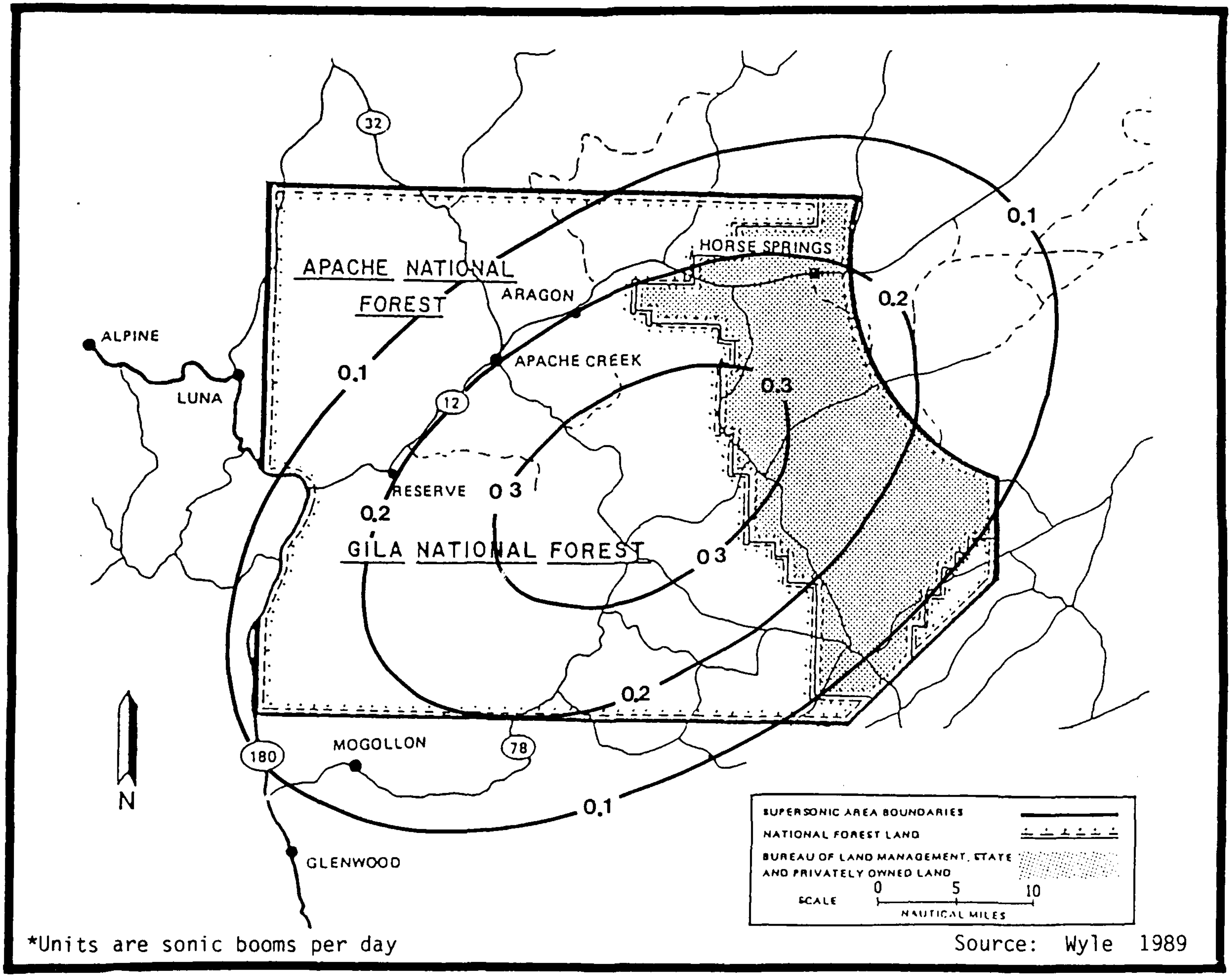


FIGURE V-4 Predicted Sonic Boom Activity at Reserve MOA Based on WSMR Model.

About 2.9 percent of these are expected to be highly annoyed by noise impacts. Considering the availability of time in the Reserve MOA, it is unrealistic to project more than 300 sorties per month, and consequently the activity at WSMR would need to maintain up to 900 sorties per month or the 49th TFW would have to accept the resultant sortie shortfall.

(2) WSMR Contingencies

There are two options that must be considered in the attempt to find more time in the WSMR airspace: (a) mission priority change and (b) weekend flying; however, neither of these would reduce the impact to the people under the WSMR airspace.

(a) Priority Change

Except for live ordnance air-to-air gunnery which has limited priority, 49th TFW usage of the WSMR must be scheduled on a daily non-interference basis. Because of their critical importance to national security and extremely high operating costs, defense research/development and operational test/evaluation projects must take priority over all other WSMR activities. Due to the potentially hazardous, rigidly controlled, and classified nature of development test projects, the only airspace where the projects can be safely/effectively flown in is within restricted areas where public access is closely guarded. The WSMR satisfies all of the above testing requirements and is one of the primary national test ranges located wholly over land within the United States.

Nothing is foreseen which would change the present non-interference scheduling policy for Holloman missions in WSMR airspace (USAF 1978). Projects are scheduled as far in advance as possible, then rescheduled on a daily basis as required for timely and economical accomplishment. The 49th TFW and 479th TTW then adjust their weekly and daily flying schedules so as to utilize the remaining range time.

(b) Weekend Flying at WSMR

The other alternative to the WSMR/Reserve option would be to consider weekend flying at WSMR. The 49th TFW could fly 50 supersonic sorties per day on weekends; however, higher priority programs (WSMR) are anticipated to cut this figure to 45 sorties (long-term basis). Thus using weekend days for two weekends could push the long-term projected WSMR sortie rate from 600 to 790 sorties per month. This option does not completely resolve the sortie shortfall and if implemented would result in a seven day workweek for base support personnel since they would have to continue providing support to the 479th TTW on Mondays through Fridays. Although the mission objective is to be combat ready seven days per week, all Air Force bases work on a regular Monday through Friday workweek during peacetime. This is true for both flight training and maintenance activities. The minor gain in sorties would have to be weighed against the reduced morale. Military families are already tasked with excessive family separations due to temporary duty and remote overseas duty. The resultant impacts are difficult to quantify; but from informal surveys of personnel currently assigned to Holloman, the impacts would be significant.

b. Use Only the White Sands Missile Range and the Valentine MOA for Supersonic Flying

If the Reserve area is not used for supersonic flights, operationally, the Valentine MOA use could potentially be increased from the projected 300 to a maximum of 600 supersonic sorties per month. The 49th TFW is the primary military user of the Valentine airspace and no substantial conflict exists with the other infrequent military/commercial users of the airspace (with the exception of the 67 TRW's infrequent use).

Up to 50 percent (600) of the 1,200 monthly F-15 supersonic required sorties could potentially be flown in the Valentine airspace; however, optimum combat capability would not likely be achieved due to the area's large distance from Holloman AFB. Approximately 30 F-15 sorties would have to use the area per day. Utilizing the data produced from the WSMR sonic boom study (300 sorties per

month), less than one sonic boom per day would be expected to be heard on the ground at any specific location. The 45 CDNL contour (Figure V-4) would be contained entirely within the Valentine MOA, which is well below equivalent EPA noise criteria (49.7 dB) for human annoyance. Doubling the sortie rate to 600 would add 3 dB to the CDNL contours and double the number of sonic booms heard.

There are three options to the WSMR/Valentine Alternative that must be considered as possible ways to reduce the impact on the local public: enlarge or reduce size of Valentine MOA and change vertical altitude. (Weekend flying at WSMR has previously been analyzed and the factors discussed also apply to this option.)

(1) Enlarge Size of the Valentine MOA

The area boundaries of the Valentine MOA have been designed to accommodate present and future supersonic operations. While enlarging the MOA would allow for establishing more operational maneuvering areas with better spacing, there are constraints that limit the size of the MOA.

No area expansion is possible to the north due to major Victor (V198) and Jet (J-2) series airways, and dut to the town of Van Horn and the numerous communities located along Interstate 10. Expansion to the east or southeast is limited by the McDonald Observatory, Harvard Radio Telescope, Davis-Mountain resort area, and the City of Marfa. Unfortunately, expansion to the east causes the distance from Holloman (over 150 NM) increases beyond the maximum operationally desired distance. Expanding area boundaries to the south appears to be environmentally suitable; however, the distance from Holloman (200 miles) again increases beyond the operationally desired distance. Any expansion of the western or southwestern area boundary is not possible due to the Mexican government's prohibition of encroachment into their airspace.

(2) Reduce Size of the Valentine MOA

A reduction in the Valentine MOA size obviously would force a reduction in the airspace available for training. This would result in an inability to select

maneuvering areas with the desired optimal terrain and minimal population density. Thus, the potential to adversely affect more people would be greater, as would the likelihood of not achieving combat readiness.

(3) Increase Minimum Altitude Boundary

The effects of sonic booms are directly related to the altitude of the supersonic aircraft. As the aircraft's altitude above the ground increases, the resulting sonic boom noise and overpressure effects decrease. The higher the minimum altitude, the less impact supersonic flight will have on the public beneath the airspace. This relationship was a predominant factor in the selection of minimum operation altitude of 15,000 ft. MSL. Although a much lower minimum altitude would significantly enhance operational combat sorties, use of altitudes below 15,000 ft. MSL were rejected as a compromise with other flight activities and in order to minimize the potential noise effects. Any upward revision of the present minimum altitude would reduce the quantity of vertical airspace available and seriously degrade the capability to support realistic air combat missions. For example, during one supersonic test, 50 percent of the pilots reported that supersonic events occurred at an altitude below 22,000 ft. MSL. Pilots would be forced to employ the aircraft in the high altitude regime where low air density causes reduced engine/airframe efficiency and decreases the maximum performance of the aircraft.

Although operation at altitudes above 30,000 ft. MSL is tactically sound during the initial intercept phase, as the engagement progresses into a three dimensional "dog fight" all participants must decrease altitude to utilize the maximum acceleration and turning performance of their aircraft.

3. Utilize Existing Airspace Outside 150 NM by Air Refueling or Temporarily Relocating the Holloman Aircraft

Since there are a number of locations within the United States where supersonic training is conducted by other units, one option considered was joint use of that airspace by the 49th TFW and the respective managing unit. This alternative

would be economically and operationally costly, but WSMR supersonic activity could be augmented in this fashion.

a. Operate From Holloman with Refueling

Holloman F-15s could operate on a very limited basis to and from the supersonic Sells MOA. The Sells airspace is the primary flying area for F-16, F-4 and F-15 aircraft operating out of Luke AFB, Arizona and A-7/A-10 aircraft from Davis-Monthan AFB, Arizona. Due to the scarcity of supersonic airspace in the southwestern United States, the Sells MOA is scheduled 90 percent of the time from sunrise to sunset for local military flying requirements. Based upon an average daylight period of 12 hours, the Sells MOA would be available approximately one to one and one-half hours per day for Holloman F-15 usage. This would equate to two or three 30 minute flying periods which would accommodate a maximum of 8 to 12 supersonic sorties per day. It is possible that some of the sorties presently using the Sells MOA do not require supersonic flight for optimum mission accomplishment.

By scheduling the non-supersonic required sorties out of the Sells MOA to other subsonic areas, increased Holloman utilization of the supersonic airspace could be attained. Assuming that sufficient shared use time was available to support the same number of sorties to the Sells MOA as projected for the Valentine and/or Reserve areas (15 sorties per day), the Sells airspace would receive an additional 12 sonic booms per day. Increasing the quantity of supersonic activity in the Sells MOA, which currently experiences an estimated 45 sonic booms per day, could represent a greater environmental impact than projected for the Valentine or Reserve areas.

Because of the greater distance involved, the operational cost per F-15 sortie to the Sells MOA will be significantly greater than the cost per sortie to the Valentine or Reserve areas. The additional costs are attributable to the increased F-15 flight time and the inflight refueling support necessary to accomplish sorties in the Sells MOA. An F-15 sortie to the Reserve or Valentine area requires a total flight time of 1.4 hours for the 280 mile round trip from

Holloman. The 1.4 hours of flying time includes 30 minutes of area flight time. To accomplish 30 minutes of flight activity on a sortie to the Sells MOA, a total flight time of 2.5 hours would be required for the 800 mile round trip. Reserve/Valentine missions can be flown without inflight refueling, while each sortie to the Sells airspace would require one KC-135 refueling aircraft per day for aerial refueling to and from the area to accomplish 30 minutes of area training time. The total flight time for each KC-135 mission would average approximately 5 hours. Using fiscal year 79 costs per flying hour (figures obtained from Headquarters Tactical Air Command Management Analysis personnel for the F-15 and KC-135) the cost per F-15 sortie for 30 minutes of supersonic flight in either the Reserve or Valentine MOA was $3,535, whereas the Sells MOA cost per sortie would be approximately $10,064.

The additional cost resulting from F-15 operations to the Sells MOA is feasible on a limited scale since each pilot must maintain refueling proficiency and aerial refueling can be accomplished in conjunction with realistic supersonic missions. This alternative, which requires refueling support on a daily basis, appears to be impractical due to excessive cost, low availability of adequate airspace time, and KC-135 tanker support.

Inflight refueling was also considered as means of utilizing the Nellis Range supersonic airspace located 500 miles west of Holloman. Compared to the Sells MOA, the Nellis Range airspace is located a greater distance from Holloman and has less range time available. Because of the costs, the Nellis airspace is not considered to be a feasible alternative.

b. Deploy Holloman Units to Satellite Locations

Another alternative for obtaining supersonic sorties is by temporarily stationing Holloman units at operating locations where there is access to supersonic airspace. However, there are important factors for not relocating either the 49th TFW or the 479th TTW.

In the environmental evaluation for the beddown of aircraft at Holloman AFB, over 84 alternate bases were evaluated for the F-15 beddown and 89 bases for the T-38 operations. Holloman is considered to be the optimum location for the F-15 and T-38 aircraft beddown based on the following criteria:

- The location is well suited for overseas deployments from the continental United States. Additionally, F-15s positioned at Holloman enhance air defense capabilities in the south central portion of the United States.

- Airspace in the vicinity of Holloman is capable of supporting supersonic flight activity over sparsely populated areas.

- Holloman is characterized by good year-round flying weather with no extended periods of weather below 2,000 ft. MSL (cloud ceilings) and three miles visibility.

- Live ordnance air-to-air (F-15) and air-to-ground (T-38) gunnery ranges are located near Holloman so that transit time enroute to and from the ranges is minimized.

- Existing base support facilities required only limited new construction to accommodate F-15 and T-38 operational requirements.

- The placement of both wings at Holloman resulted in a net increase of 70 personnel as opposed to the 770 decrease in base personnel that would have occurred if the T-38 wing had been located elsewhere. The desirable operational attributes of the Holloman location and the high costs normally involved in moving to and setting up operations at another base make relocation of either the 479th TTW or the 49th TFW very costly, and operationally impractical.

One Valentine area resident at a local project scoping meeting suggested that the 49th TFW be relocated to a Texas Gulf Coast military base to conduct supersonic flights over water. Proposed locations near overwater supersonic areas were evaluated and eliminated from consideration based on one or more of the following reasons:

- Location within the United States with respect to employment/deployment considerations.

- Availability of air combat maneuvering supersonic airspace/ranges.

- Presence of an existing mission programmed for long-term activity on the base.
- Marginal weather conditions for tactical operations.
- Local community encroachment problems.
- Gross facility deficiencies.

(1) Nellis AFB Range Complex

The Nellis range complex is located north of Las Vegas, Nevada, approximately 500 miles northwest of Holloman. Due to the distance from Holloman, the only practical alternative for utilization of this airspace would involve deploying a unit to Nellis AFB. Before examining the advantages and the disadvantages of a satellite operating location, the availability of area time for Holloman to use the Nellis Range complex must first be considered. The Nellis Air Force Base complex has and is being used extensively to support mission requirements of combat ready flying units permanently stationed at Nellis AFB.

Additionally, because the areas are large, supersonic certified, and have minimum operation restrictions, the range area provide invaluable tactical training for aircrews participating in Tactical Air Command Exercises allowing combat ready pilots from units located throughout the United States to periodically deploy to Nellis AFB and practice, evaluate and refine combat tactics in a simulated, but very realistic, wartime environment. The continual scheduling demand for Nellis range airspace by the training exercises and the flying units stationed at Nellis results is nearly 100 percent utilization of the areas during the daylight hours. Although 49th TFW pilots use the airspace on a short-term basis while participating in the periodic exercises, any long-term shared use of the areas is not considered feasible due to existing airspace utilization, travel cost and expense to support a satellite operation. If adequate shared use time was available on the Nellis Range Complex, the costs associated with temporarily deploying squadrons there for supersonic sorties would be approximately the same as for the Tyndall AFB, Florida operation discussed later.

(2) Florida AFBs with Overwater Supersonic Training Areas

To examine specific problems associated with satellite operating locations, there are a number of Air Force bases located in Florida where supersonic overwater areas are available and existing area utilization would support significant 49th TFW shared usage. By continuously maintaining one of the three Holloman F-15 squadrons at a satellite base having access to supersonic airspace, approximately 33 percent more F-15 sorties would have supersonic capability. If this option was employed to augment existing F-15 supersonic capability (50 percent WSMR) a total of 83 percent of the 49th TFW F-15 sorties could be flown in supersonic approved airspace. Although the 33 percent represents a significant increase above present supersonic capability, the operational practicality and cost effectiveness of such an alternative are questionable for the following reasons.

To avoid the prohibitive expense of maintaining a complete on-site parts inventory, replacement of aircraft parts would be maintained at Holloman and transported to the operating location when required. In addition to increased transportation costs, the time delay in getting parts from Holloman would reduce aircraft in commission rates at the operating location. With a third of the wing deployed away from Holloman on a long-term basis, the wing's quick reaction deployment posture would be seriously degraded. In the event the wing was tasked to mobilize for rapid worldwide deployment, critical time would be lost by not having a significant portion of the wing resources at home and immediately available.

The adverse impact on the morale of Air Force personnel required to support this alternative is another factor which must be considered. While deployed to the operating base, families of operations and maintenance personnel would have to remain at Holloman. The necessity for family separation is accepted in the military; however, the validity of forced family separation to accomplish supersonic training at a satellite location when that flying could be reasonably accomplished in areas near Holloman would be seriously questioned. If the

alternative was implemented, to lessen the resulting family separation impact, each squadron at Holloman would rotate personnel to serve a maximum of 60 days at the temporary operating base.

An additional factor relating to satellite base operations must be considered. Although supersonic training over water would expose very few people to sonic booms, deployed operations would increase the number of takeoffs and landings at the satellite operating base, resulting in an increased noise impact on populated areas near the base.

The following data summarizes the major costs required to deploy and maintain an F-15 squadron (24 aircraft) at Tyndall Air Force Base, Florida. Tyndall was selected as an example because of its access to supersonic areas over the Gulf of Mexico where minimum environmental impact would be anticipated. Cost estimates are based upon deploying/maintaining a squadron size detachment at Tyndall AFB for one year with a rotation of personnel back to Holloman every 50 days. A squadron size operation requires 291 enlisted and 37 officers for a total personnel package of 328. The total cost per year to accomplish this alternative, using fiscal year 1979 costs, is estimated to be $29,646,024. The total includes deployment costs, temporary duty personnel costs, personnel rotation costs, and F-15 flying time/sortie operational costs. Computations used to derive both individual and total operating costs are provided in Appendix F of the Valentine MOA Environmental Impact Statement (USAF 1979).

Based on the lack of supersonic airspace where 49th TFW F-15 sorties could operate on a shared basis without the need for costly inflight refueling and/or satellite operating bases, the potential of this alternative to provide required proficiency is limited. Although such short-term operations would be practical to some degree, on a long-term basis shared use of distant supersonic areas in lieu of establishing local supersonic areas does not appear feasible.

4. Utilize Mexican Airspace

This alternative was not considered feasible even though the area met the selection criteria. Mexican constitutional restrictions do not allow foreign military aircraft training over Mexico.

5. Create New Airspace

The potential for establishing a new MOA for T-38 and/or F-15 operations is very limited due to the present number of MOAs, restricted areas, and high/low altitude airways (see Figure V-2). All airspace within operating range of the T-38 (90 NM) is completely saturated with existing areas and airways. Therefore, the feasibility of developing another area for T-38 operations and allow F-15 use of the Talon area appears unlikely. When the 150 nautical mile operating range is considered, possibilities for establishing a new area are limited due to the concentrated network of high and low altitude airways. In no case would it be possible to propose even a 40 x 40 nautical mile flying area without deleting or re-routing at least two or more high/low altitude airways. Due to the amount of civilian traffic utilizing routes in the vicinity of El Paso, Albuquerque, Tucson and Roswell, the ramifications associated with implementing this action are significant. If existing airways could be relocated, it is very likely that the resulting area would not be as sparsely populated.

6. No Action

Acceptance of this option would result in continuation of aircraft emissions stated in Table IV-1. Noise levels would also remain in the low 40 DNL range which is typical of a rural community. From an operational standpoint, the 49th TFW would continue to squeeze as many supersonic sorties as possible into the WSMR and Reserve airspaces, resulting in degraded missions. If no additional supersonic airspace was found, approximately 300 to 600 sorties per month could not be performed; those flown would be limited in time and are resulting in less effective training. If the Reserve MOA could be used for supersonic training, the 49th TFW could meet the sortie requirement during the months WSMR could

accommodate 900 sorties; however, again the WSMR sorties would continue to be degraded and the 49th TFW mission would be in jeopardy.

C. Summary

No action to increase the quantity of supersonic airspace would restrict realistic flight operations and significantly degrade the wartime effectiveness and survivability of F-15 aircrews. Except for the Valentine area and a portion of the Reserve area, existing or new areas located within 150 NM of Holloman are not considered feasible alternatives for supersonic flights. Compared to the Valentine and Reserve areas, alternative supersonic areas would result in a negative impact on existing military utilization, commercial general aviation traffic and would expose significantly more people to sonic boom activity.

The capability of sharing supersonic airspace managed by other units is limited by the transit distance required to conduct the operation. Except for WSMR, the nearest supersonic airspace is 400 miles from Holloman. To obtain the same area-time per sortie, costly inflight refueling and long F-15 transit times would be necessary to support this alternative.

The costs, degraded deployment posture and operation limitations resulting from deploying a squadron to a satellite location for shared use supersonic activity area are unattractive when compared to local flights to the Valentine/Reserve area(s).

From a cost effective and operationally practical view, supersonic activity utilizing airspace within 150 NM of Holloman AFB appears to be a desirable alternative.

Because of the operational and environmental suitability of the Valentine area, it appears that supersonic operations would impact that area the least of any area considered except the Reserve MOA. Relocation of the 49th TFW or 479th TTW is considered impractical because of the desirable attributes of the Holloman

location and the excessive costs required to move and set up operations at another base, aside from the economic impact on the local community.

Although the sonic boom impact of 600 sorties per month in either Valentine or Reserve compare favorably with EPA noise annoyance criteria, the Air Force proposes to divide the sorties equally between the two MOAs. This would help reduce noise impacts and provide for greatest mission enhancement. While the Reserve MOA can accommodate only one-half the long term sortie shortfall, it does provide for intercept training against dissimilar type aircraft that do not carry enough fuel to fly to the Valentine MOA. The 49th TFW needs to periodically fly supersonic on the intercept missions in order to take advantage of the F-15s capability. The combination of Reserve/WSMR would result in the 49th TFW continuing to train in a manner that does not provide for maximum efficiency on each mission conducted in WSMR. Considering fiscal constraints and the cost of flying aircraft, the Air Force must assure that each pilot is able to achieve the mission objectives on each sortie. Splitting the 600 sortie shortfall between Reserve and Valentine would provide for mission objectives while at the same time minimizing the impact of sonic booms on any one area.

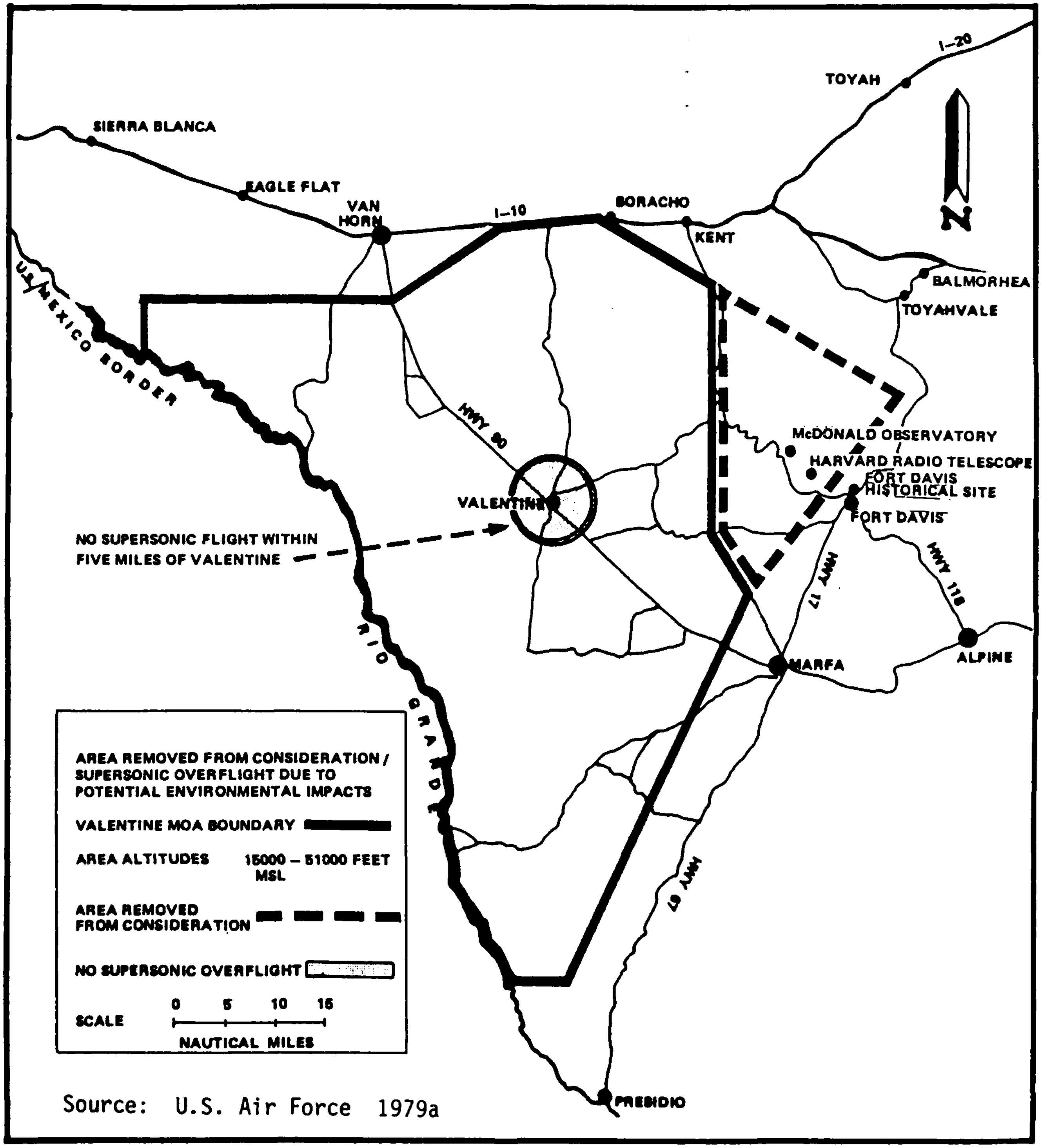
VI. MITIGATING MEASURES

In order to reduce the potential effect of periodic supersonic flight, several actions have been and will be undertaken by TAC. Most of these actions are directed toward reducing the opportunity for noise or restricting the time and location where noise may cause annoyances.

A. Land Use and Annoyance

The 49th TFW has already taken a number of actions to minimize the impact of the proposed intermittent supersonic training on the present and future land uses of the area. First, the limits of the eastern boundary were established with consideration of scientific observation/experimentation facilities and historical attractions located in the Davis Mountains near Fort Davis as shown in Figure VI-1. Second, the minimum operational altitude proposed for the area was established as 15,000 ft. MSL. The relatively high altitude (8,000-10,000 ft. above ground), as opposed to ground level, was selected as a compromise to allow realistic F-15 training while minimizing interference with other domestic flight activities as well as noise and overpressure effects experienced at ground locations. Third, no supersonic flights are authorized within a five nautical mile radius of the town of Valentine.

Also, an important step in minimizing the number of people who will hear sonic booms is the designation of a restricted zone with a 5-mile radius centered onthe City of Valentine, in which supersonic flight will not be allowed. The Air Force has documented that essentially all actual combat maneuvering in which supersonic flight takes place occurs while the aircraft are within an area about 12 miles wide and 18 miles long. However, in the WSMR sonic boom study for model development, tracking data showed the operating area was 35 x 60 statute miles. There are numerous possible operating areas of this size within the Valentine MOA which still fall outside of the 5-mile restricted zone near the City of Valentine.



Source: U.S. Air Force 1979a

FIGURE VI-1 Land Use Mitigation For Local Attractions

An additional factor which will mitigate the impact of supersonic training is minimum weekend/holiday flying activities and restriction of daily sorties to daylight hours only. It is estimated that on an annual basis, the Valentine area will be used less than five total weekend or holiday periods.

B. Claims Policies and Procedures

Claims for property damage and personal injury as a result of Air Force sonic boom activities are processed in accordance with the procedures set out in Air Force Manual 112-1. Claims for sonic boom damage are most often handled under Chapter 7 of the manual which implements the Military Claims Act (Title 10, United States Code, Section 2733). This Act authorizes the Air Force to pay for damages or injuries caused by "noncombat activities". A "noncombat activity" includes supersonic flights and sonic booms that are created by such flights. A claimant need not allege or prove a negligent or wrongful act by military or Air Force civilian personnel in order to recover under this policy. The claimant need only prove a "casual connection" between the authorized noncombat activity and the injury or damage claimed.

Sonic boom claims for damage may be denied for one of two reasons: (1) There was no Air Force aerial activity being conducted at the time the damage occurred, or (2) the damage resulted from other causes such as structural deficiencies or water damage. In some cases, partial payment is made on a claim because, although the sonic boom was not the only cause of the damage, it may have been contributing factor. An apportionment is made equal to the damages caused by the sonic boom versus the other cause(s).

C. Related Sonic Boom Study

A sonic boom study was conducted at the WSMR as part of this environmental document. The purpose of the study was to record sonic boom events on a network of sound recorders designed for noise analysis. A computer model was employed to extrapolate these noise date from the WSMR to the Valentine MOA based upon anticipated flight patterns. The results of the extrapolation indicate the

overpressures and noise levels that might actually be expected at ground levels at the Valentine MOA.

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VIII. ACRONYMS AND ABBREVIATIONS

ACMI - Air Combat Maneuvering Instrumentation

AFB - Air Force Base

AFR - Air Force Regulation

AGL - Above Ground Level

ALL - Airborne Laser Laboratory

AQCR - Air Quality Control Region

ATC - Air Training Command

ATCAAA - Air Traffic Control Assigned Airspace Area

B.P. - Before Present, which means before 1950

CFR - Code of Federal Regulations

dB - Decibels

DIVAD - Division Air Defense

DNL - Day-Night Level

EID - Environmental Improvement Division

FAA - Federal Aviation Administration

FACC - Ford Aerospace and Communications Corporation

FL - Flight Level

FONSI - Finding of No Significant Impact

ft. - feet

GBFEL-TIE - Ground Based Free Electron Laser-Technology Integration Experiment

gpm - gallons per minute

HUD - Housing and Urban Development

km - Kilometer

LRF - Laser Range Finder

mm - millimeters

MOA - Military Operations Area

mph - Miles Per Hour

MSL - Mean Sea Level

MTR - Military Training Route

NAAQS - National Ambient Air Quality Standards

NM - Nautical Mile

OSHA - Occupational and Safety Health Administration

ppm - parts per million

PSD - Prevention of Significant Deterioration

SM - Statute Mile

TAC - Tactical Air Command

TDS - Total Dissolved Solids

TFW - Tactical Fighter Wing

TSP - Total Suspended Particulates

TTW - Tactical Training Wing

USAF - United States Air Force

USEPA - United States Environmental Protection Agency

USFWS - United States Fish and Wildlife Service

WSMR - White Sands Missile Range

APPENDIX A

Texas Threatened and Endangered Plant Species
Identified by the Texas Natural Heritage Program
November 1987

Acacia schotti, Schott acacia
Federal Status:
State Rank: S3
Counties: Brewster, Presidio

Penstemon harvardii, Harvard penstemon
Federal Status:
State Rank: S3
Counties: Culberson, Jeff Davis, Presidio

Astragalus gypsodes, Gyp locoweed
Federal Status: C2
State Rank: S2
Counties: Culberson

Nolina arenicola, sand sacahwista
Federal Status: C2
State Rank: S2
Counties: Culberson, Hudspeth

Symphoricarpos guadalupensis, McKittrick snowberry
Federal Status: C2
State Rank: S1
Counties: Culberson

Festuca ligulata, Guadalupe fescue
Federal Status: C2
State Rank: S1
Counties: Culberson

Aquilegia chaplinei, McKittrick columbine
Federal Status: C3
State Rank: S2
Counties: Culberson, Presidio

Perityle quinqueflora, Fiveflower rackdaisy
Federal Status:
State Rank: S3
Counties: Culberson, Hudspeth, Jeff Davis, Presidio

Scutellaria laevis, Smooth stem skullcap
Federal Status: C2
State Rank: S1
Counties: Culberson, Hudspeth

Polygala rimulicola, Rock crevice daisy
Federal Status: C3
State Rank: S2
Counties: Culberson

Euphorbia chaetocolyx, Three-tongued spurge
Federal Status:
State Rank: S1
Counties: Culberson

Croton suaveolens, Scented croton
Federal Status:
State Rank: S2
Counties: Culberson

Prunus murrayana, Murray plum
Federal Status: C3
State Rank: S2
Counties: Culberson, Jeff Davis

Chaetopappa hersheyi, Mat leastdaisy
Federal Status: C2
State Rank: S2
Counties: Culberson, Hudspeth

Salvia summa, Mountain sage
Federal Status:
State Rank: S2
Counties: Culberson

Carex muriculata, Rough-fruited sedge
Federal Status:
State Rank: S4
Counties: Culberson

Penstemon cardinalis, Royal red penstemon
Federal Status:
State Rank: S2
Counties: Culberson, Jeff Davis

Berlandiera lyrata, Bigleaf green eyes
Federal Status:
State Rank: S2
Counties: Culberson, Jeff Davis, Presidio

Polygala rimulicola, Rock crevice milkwat
Federal Status:
State Rank: S2
Counties: Culberson, Hudspeth

Hedeoma apiculatum, McKittrick pennyroyal
Federal Status: LT
State Status: T
State Rank: S2
Counties: Culberson

Agave glomeruliflora, Chisos agave
Federal Status: C2
State Rank: S2
Counties: Culberson, Hudspeth

Strepthanthus sparsiflorus, Sparsely-flowered jewelflower
Federal Status: C2
State Rank: S2
Counties: Culberson

Lycium texanum, Texas wolf-berry
Federal Status: C3
State Rank: S1
Counties: Culberson, Hudspeth

Lesquerella valida, Trong bladderpod
Federal Status: C3
State Rank: S1
Counties: Culberson, Hudspeth

Pseudoclappia arenaria, Sand false clappia bush
Federal Status:
State Rank: S2
Counties: Culberson, Hudspeth

Aquilegia chaplinei, Guadalupe mountains columbine
Federal Status:
State Rank: S2
Counties: Culberson

Hymenopappus biennis, Biennial woolywhite
Federal Status:
State Rank: S2
Counties: Culberson

Valeriana texana, Guadalupe valerian
Federal Status: C3
State Rank: S2
Counties: Culberson

Pseudoclappia watsonii, Watson's false clappia bush
Federal Status:
State Rank: S1
Counties: Hudspeth, Jeff Davis

Brickellia brachyphylla var. terlinguensis, Terlingua brickellbush
Federal Status:
State Rank: S1
Counties: Hudspeth

Euphorbia golondrina, Swallow spurge
Federal Status: C2
State Rank: S2
Counties: Hudspeth

Amulocaulis leiosolenus, Surgstem
Federal Status:
State Rank: S2
Counties: Hudspeth, Presidio

Lepidospartum burgesii, Gypsum Scalebroom
Federal Status: C2
State Rank: S1
Counties: Hudspeth

Castilleja ciliata, Fringed paintbrush
Federal Status: C2
State Rank: S1
Counties: Jeff Davis

Arenaria livermorensis, Livermore sandwort
Federal Status: C2
State Rank: S1
Counties: Jeff Davis

Zanthoxylum parvum, Shinner's tickle-tongue
Federal Status: C2
State Rank: S1
Counties: Jeff Davis

Sedum harvardii, Harvard stonecrop
Federal Status:
State Rank: S2
Counties: Jeff Davis

Grindelia scabra, Rough gumweed
Federal Status:
State Rank: S2
Counties: Jeff Davis

Croton suaveylens, Scented onion
Federal Status:
State Rank: S2
Counties: Jeff Davis

Brickellia brachyphylla var. hinckleyi
Federal Status: C2
State Rank: S2
Counties: Jeff Davis

Polemonium pauciflorum, Davis Mts. Jacob's Ladder
Federal Status:
State Rank: S1
Counties: Jeff Davis

Quercus depressipes, Mexican dwarf oak
Federal Status:
State Rank: S1
Counties: Jeff Davis

Osmorhiza bipatriata, Livermore cicely
Federal Status: C2
State Rank: S1
Counties: Jeff Davis

Philadelphus crinitus, Bearded mockorange
Federal Status:
State Rank: S1
Counties: Jeff Davis

Castilleja elongata, tall paintbrush
Federal Status: C2
State Rank: S2
Counties: Jeff Davis

Potamogeton clystocarpus, pondweed
Federal Status: C1
State Rank: S1
Counties: Jeff Davis

Styrax youngae, Young's silverbells
Federal Status: C2
State Rank: S1
Counties: Jeff Davis

Polypodium erythrolepis, Lance-leaf polypody
Federal Status:
State Rank: S2
Counties: Jeff Davis

Grindelia scabra, Rough gumweed
Federal Status:
State Rank: S2
Counties: Jeff Davis, Presidio

Solanum leptosepalum, Feral spud
Federal Status:
State Rank: S1
Counties: Jeff Davis, Presidio

Astragalus mollissimus var. marcidus, Withered wooly loco
Federal Status:
State Rank: S2
Counties: Jeff Davis, Presidio

Selaginella viridissima, Green spikemoss
Federal Status:
State Rank: S1
Counties: Jeff Davis

Pinyon-Oak-Juniper Series
Federal Status:
State Rank: S4
Counties: Jeff Davis

Ponderosa Pine Series
Federal Status:
State Rank: S3
Counties: Jeff Davis

Quercus hinckleyi, Hinckley's oak
Federal Status: C1
State Rank: S1
Counties: Jeff Davis, Presidio

Mimulus dentilobus, Fringed monkeyflower
Federal Status:
State Rank: S1
Counties: Jeff Davis, Presidio

Velvet Ash-Gooding Willow Series
Federal Status:
State Rank: S2
Counties: Presidio

Perityle aglossa, Rayless rockdaisy
Federal Status:
State Rank: S3
Counties: Presidio

Euphorbia perennans, Perennial euphorbia
Federal Status:
State Rank: S2
Counties: Presidio

Echinocereus lloydii, Lloyd's hedgehog cactus
Federal Status: LE
State Status: E
State Rank: S1
Counties: Presidio

Thelypodium texanum, Texas thelypody
Federal Status: C3
State Rank: S2
Counties: Presidio

Lycium berberioides, Silver wolfberry
Federal Status: C2
State Rank: S2
Counties: Presidio

Perityle dissecta, Shinlobe rockdaisy
Federal Status:
State Rank: S2
Counties: Presidio

Aquilegia hinckleyana, Hinckley's columbine
Federal Status: C2
State Rank: S1
Counties: Presidio

Eriogonum suffruticosum, Bushy wild buckwheat
Federal Status: C2
State Rank: S2
Counties: Presidio

Thelypodium tenue, Fresno thelypody
Federal Status: C3
State Rank: S1
Counties: Presidio

Gaura boquillensis, Boquillas lizardtail
Federal Status:
State Rank: S2
Counties: Presidio, Brewster

Brickellia viejensis, Sierra Vieja brickellia
Federal Status: C2
State Rank: S2
Counties: Presidio

Eysenhardtia spinosa, Spiny kidneywood
Federal Status:
State Rank: S2
Counties: Presidio

Euphorbia golondrina, Swallow spurge
Federal Status: C2
State Rank: S2
Counties: Presidio

Eleocharis cylindrica, Cylinder spike-rush
Federal Status: C2
State Rank: S1
Counties: Presidio

Kallstroemia perennans, Perennial caltrap
Federal Status: C2
State Rank: S1
Counties: Presidio